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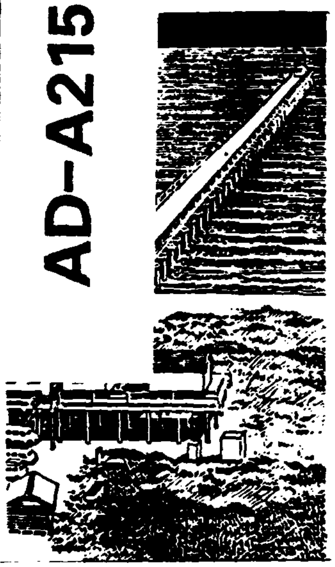
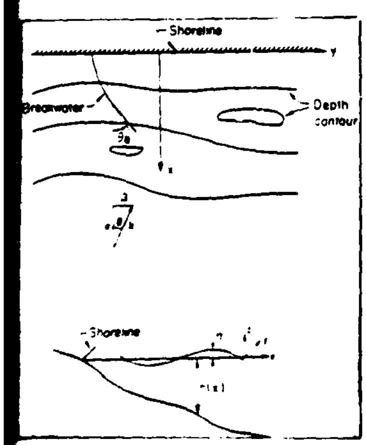
NUMERICAL MODEL COMPUTING WAVE PROPAGATIONS IN AN OPEN COAST





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In this report, numerical models, based on the parabolic approximation for computing wave propagation, are presented. The theoretical background for the mild-slope assumption and the parabolic approximation is first summarized. Three different numerical models, using different coordinate systems, are then developed. These models calculate the combined wave refraction and diffraction over varying depth and current and in the vicinity of coastal structures. To verify the validity of the numerical models, numerical results are compared with laboratory and field data.

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PREFACE

This report presents the results of the development of a numerical model capable of simulating wave propagation over an open coastline and in the vicinity of inlets and entrances. The research in this report was authorized by the Office, Chief of Engineers (OCE), US Army Corps of Engineers, under the Harbor Entrances and Coastal Channels Program, through the "Modeling Coastal Processes" Work Unit 32240 at the Coastal Engineering Research Center (CERC) of the US Army Engineer Waterways Experiment Station (WES). Resources for publication and distribution of this report were provided through the "Inlet Processes Simulation" Work Unit 32527 of the Harbor Entrances and Coastal Channels Program, CERC, WES. Messrs. John H. Lockhart, Jr., and John G. Housley of OCE were the CERC Contract Monitors. Dr. Charles L. Vincent of CERC was the Program Manager.

This report was prepared by Dr. Ting-Kuei Tsay of Syracuse University, Syracuse, New York, and by Dr. Philip L.-F. Liu of Cornell University, Ithaca, New York. CERC Contract Monitor was Mr. Bruce Ebersole, former Principal Investigator of "Modeling Coastal Processes" Work Unit, Coastal Processes Branch (CR-P), Research Division (CR), CERC. The work was performed under the direct supervision of Dr. Steven A. Hughes, former Chief, CR-P, and Mr. H. Lee Butler, Chief, CR, and under general supervision of Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC, and Dr. James R. Houston, Chief, CERC.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

NUMERICAL MODEL COMPUTING WAVE PROPAGATIONS IN AN OPEN COAST

1. INTRODUCTION

Numerical results based on the linear, parabolic wave equation have been reported recently by several researchers (e.g., Tsay and Liu, 1982; Dingemans, 1983; Liu and Tsay, 1985; Kirby and Dalrymple, 1986). The linear, parabolic wave equation describes wave propagation over a complex bottom topography and/or a current field where both refraction and diffraction are important. For a given problem, solutions of the parabolic equation require less computing time and storage than solutions of the mild-slope equation (an elliptic equation). The linear parabolic wave equation method is, perhaps, most suitable for computing the wave height distribution and propagation directions over a regional scale because of the relative low computational requirements.

In this report, numerical models based on the parabolic approximation are presented. The theoretical background of the models is first summarized in section 2. The theory presented in this section is an extension of Tsay and Liu's (1982) work. A more detailed explanation of the method and justifications for its application can be found in Liu (1986). Although nonlinear parabolic wave equations have already been developed for both Stokes and shallow water waves (Liu, et al., 1986; Kirby, 1986; Yoon, 1987), the discussion reported herein is limited to linear wave theory. Three numerical models, each using a different coordinate system, are discussed in detail.

Numerical results are presented in section 3. Three sets of laboratory and field data are used to verify the accuracy of the numerical models. For each example, sample input/output data files are included in an appendix. In section 4 a flow-chart and description of input-output data files are presented. A listing of the computer program is also presented in this section.

2. THEORETICAL BACKGROUND

The derivation of the parabolic wave equation for small amplitude waves can be found in recent literature (e.g., Radder, 1979; Lozano and Liu, 1980; Liu, 1983; Kirby, 1986). In this section we only summarize the essential theoretical information needed to follow the numerical model development. The reader can also consult the report by Liu (1986) for a more detailed discussion of the parabolic approximation method.

2.1 The Mild-slope and Parabolic Wave Equations

Consider the propagation of a small amplitude, monochromatic wave train with frequency ω over a gradually varying water depth, $z = -h(x,y)$, and a current field. Denoting $\Phi(x,y,t)$ as the velocity potential on the mean free surface, $z = 0$, the mild-slope equation can be written as (Liu, 1983; Kirby, 1984):

$$\frac{D^2\Phi}{Dt^2} + (\nabla \cdot \vec{u}) \frac{D\Phi}{Dt} - \nabla \cdot (CC_g \nabla\Phi) + (\Omega^2 - k^2 CC_g - i \omega W) \Phi = 0, \tag{2.1}$$

where $\nabla = (\partial/\partial x, \partial/\partial y)$, $\vec{u} = \vec{u}(x,y)$ denotes the current velocity vector, and Ω is the intrinsic wave frequency, which satisfies the dispersion relation:

$$\Omega^2 = gk \tanh kh \quad , \tag{2.2}$$

in which k is the wave number and h is the water depth. The dispersion relation can be used to calculate the phase velocity, $C = \Omega/k$, and the group velocity, $C_g = d\Omega/dk$. Because of the appearance of the ambient current, there is a difference between the intrinsic frequency and the wave frequency ω, i.e.,

$$\Omega = \omega - \vec{k} \cdot \vec{u} \quad . \tag{2.3}$$

In (2.1) the total time derivative is defined as:

$$\frac{D}{Dt} = \frac{\partial}{\partial t} + \vec{u} \cdot \nabla \qquad , \tag{2.4}$$

and W represents the rate of energy dissipation per unit wave energy per wavelength (Booij, 1981).

For monochromatic waves the velocity potential can be written in the following form:

$$\Phi(x,y,t) = \phi(x,y)\ e^{-i\omega t} \qquad . \tag{2.5}$$

The free-surface displacement $z = \eta(x,y)\ \exp(-i\omega t)$ can also be related to the velocity potential as follows:

$$\Phi(x,y,t) = -\frac{ig}{\Omega}\ \eta(x,y)\ e^{-i\omega t} . \tag{2.6}$$

Therefore, from (2.5) and (2.6)

$$\eta(x,y) = \frac{i\Omega}{g}\ \phi(x,y). \tag{2.7}$$

Substituting (2.5) into (2.1) yields

$$\vec{u} \cdot \nabla(\vec{u} \cdot \nabla\phi) - 2i\omega\vec{u} \cdot \nabla\phi + (\nabla \cdot \vec{u})\ (\vec{u} \cdot \nabla\phi)$$
$$- \nabla \cdot (CC_g\ \nabla\phi) + [\Omega^2 - \omega^2 - i\omega\nabla \cdot \vec{u} - k^2CC_g - i\omega W]\ \phi = 0. \tag{2.8}$$

The above equation can be viewed as a mild-slope equation for wave-current interaction. For a weak current field, such that

$$O(CC_g) >> O(|\vec{u}|^2), \tag{2.9}$$

(2.8) can be reduced to be

$$\nabla \cdot (CC_g\ \nabla\phi) + 2i\omega\vec{u} \cdot \nabla\phi + [k^2CC_g + 2\ \vec{k} \cdot \vec{u}\ \Omega + i\omega\ \nabla \cdot \vec{u} + i\omega W]\ \phi = 0. \tag{2.10}$$

If the current field is zero, (2.10) can be further simplified to give

$$\nabla \cdot (CC_g \nabla\phi) + [k^2 CC_g + i\omega W]\, \phi = 0. \tag{2.11}$$

Without considering the energy dissipation term W, Berkhoff (1972) derived the mild-slope equation describing wave propagations over a slowly varying topography. Different derivations of the same equation were also given independently by Smith and Sprinks (1975) and Lozano and Meyer (1976). The basic assumption employed in the mild-slope equation derivation is that the percentage of change of water depth within a characteristic wavelength is small, i.e., $O(|\nabla h|/kh) \ll 1$. The mild-slope equation reduces to the Helmholtz equation in the deep-water limit and to the shallow-water wave equation in the shallow-water limit.

Following Tsay and Liu's (1982) approach, the water depth is split into two components; i.e.,

$$h(x,y) = \bar{h} + h \quad . \tag{2.12}$$

The wave number corresponding to the modified depth, $\bar{h}$, is $\bar{k}$. The first criterion for selecting the modified topography is that no caustic shall appear in the wave field associated with the modified depth. Secondly, the differences between the actual wave number, k, and the modified wave number, $\bar{k}$, must be small, i.e.,

$$k^2 = k^2 - \bar{k}^2 << 1 \quad . \tag{2.13}$$

A numerical procedure for defining the modified water depth is given in section 2.3.

We now propose a solution form for the velocity potential:

$$\phi = FAe^{iS} \quad , \tag{2.14}$$

where S and A are determined by the eikonal equation and the transport equation associated with the modified wave number, $\bar{k}$, i.e.,

$$\bar{k}^2 = (\nabla S)^2 \quad , \tag{2.15}$$

$$\nabla S \cdot \nabla (A^2 CC_g) + (\nabla^2 S) A^2 CC_g = 0 \quad . \tag{2.16}$$

The amplitude function, A, and the phase function, S, characterize the background wave field. The quantity F in (2.14) represents the diffraction factor resulting from perturbations in depth, $\hat{h}$, current field, and gradients of the amplitude function A.

Substitutions of (2.14) - (2.16) into (2.10) yield the following approximate equation for F:

$$\begin{aligned}[2i\,(\vec{\bar{k}} + \frac{\vec{u}\,\omega}{G}) + (\frac{2\nabla A}{A} + \frac{\nabla G}{G})] \cdot \nabla F + \nabla^2 F + [\hat{k}^2 + \frac{1}{G}\,(2\Omega\vec{k} \cdot \vec{u} - 2\omega \\ \vec{k} \cdot \vec{u} + i\omega\nabla \cdot \vec{u} + iW\omega)]\, F = 0 \quad ,\end{aligned} \tag{2.17}$$

where $G = CC_g$. In the case where $\vec{u} = 0$, the above equation becomes

$$2i\bar{k} \cdot \nabla F + (\frac{2\nabla A}{A} + \frac{\nabla G}{G}) \cdot \nabla F + \nabla^2 F + (\hat{k}^2 + \frac{iW\omega}{G})\, F = 0. \tag{2.18}$$

We remark here that the second term in (2.18) represents the effects of the slopes of background wave amplitude and topography. This term was ignored in Tsay and Liu (1982). Equations (2.17) and (2.18) are elliptic equations. In (2.17) the wave number vector $\vec{k}$ remains a unknown. In principle, it may be found by solving the dispersion relation and the equation describing the irratationality of the wave number vector, i.e., $\nabla \times \vec{k} = 0$. Equation (2.13) can be expressed as

$$\hat{k}^2 = (k^2 - k_1^2) + (k_1^2 - \bar{k}^2) \tag{2.19}$$

where k_1 is wave number corresponding only to depth variation (i.e. $\omega^2 = gk_1 \tanh k_1h$). In the shallow water region, one can use the following aproximation (Liu, 1983):

$$k^2 - k_1^2 = -\frac{1}{gh}(2\Omega\,\vec{k}\cdot\vec{u}) \quad . \tag{2.20}$$

Thus, (2.17) can be approximated to be:

$$[2i\,(\vec{k} + \frac{\vec{u}\,\omega}{G}) + (\frac{2\nabla A}{A} + \frac{\nabla G}{G})]\cdot\nabla F + \nabla^2 F + \frac{1}{G}\,[G(k_1^2 - \bar{k}^2)$$
$$+ i\omega\nabla\cdot\vec{u} + iW\omega - 2\omega\,\vec{\bar{k}}\cdot\vec{u}]\,F = 0. \tag{2.21}$$

The information on $\vec{k}$ is no longer needed in the above equation.

We may now introduce the parabolic approximation by assuming that the diffraction factor, F, varies more rapidly in the direction along the phase line than in the direction of wave propagation of the background wave field. Denoting ρ = constant and σ = constant as the background wave rays and phase lines, respectively, we approximate (2.21) to be

$$[2i\,(\bar{k} + \frac{U\omega}{G}) + \frac{2A_\sigma}{A} + \frac{G_\sigma}{G}]\,F_\sigma + (\frac{2iV\omega}{G} + \frac{2A_\rho}{A} + \frac{G_\rho}{G})\,F_\rho + \nabla_\rho^2\,F + \frac{1}{G}$$
$$[i\omega\nabla\cdot\vec{u} + i\omega W + G(k_1^2 - \bar{k}^2) - 2\omega\,\vec{\bar{k}}\cdot\vec{u}]\,F = 0 \tag{2.21}$$

where (U,V) are the current velocity components in the σ- and ρ- directions, respectively and the partial derivatives are defined as:

$$(\quad)_\sigma = \frac{1}{h_\sigma}\frac{\partial}{\partial\sigma} \quad , \; (\quad)_\rho = \frac{1}{h_\rho}\frac{\partial}{\partial\rho} \quad , \tag{2.23}$$

$$\nabla_\rho^2 = \frac{1}{h_\rho^2}\frac{\partial^2}{\partial\rho^2} + \frac{1}{h_\sigma h_\rho}\,[\frac{\partial}{\partial\rho}\,(\frac{h_\sigma}{h_\rho})]\,\frac{\partial}{\partial\rho} \quad , \tag{2.24}$$

where h_σ $(= |\partial r/\partial\sigma|)$ and h_ρ $(= |\partial r/\partial\rho|)$ are scale factors, giving the ratios

where h_σ ($= |\partial r/\partial\sigma|$) and h_ρ ($= |\partial r/\partial\rho|$) are scale factors, giving the ratios of differential distances, ∂r, to the differentials of the coordinate "parameters". Equation (2.22) is the well-known Schrodinger equation. If the coefficients in (2.22) were real, the equation could be interpreted as a heat equation with σ as a time-like variable; the second term in (2.22) represents the convection and the third term denotes diffusion in the ρ-direction.

When the ambient current field is ignored, a similar parabolic wave equation can be obtained from (2.18) directly. Thus,

$$(2i\bar{k} + \frac{2A_\sigma}{A} + \frac{G_\sigma}{G}) F_\sigma + (\frac{2A_\rho}{A} + \frac{G_\rho}{G}) F_\rho + \nabla_\rho^2 F + (\bar{k}^2 + \frac{iW\omega}{G}) F = 0. \tag{2.25}$$

2.2 The Background Wave Field

Once the modified topography is chosen, the background wave field can be determined numerically, in principle, from (2.15) and (2.16) with the appropriate boundary conditions. If the modified depth is assumed to be uniform in the alongshore direction, i.e.,

$$\bar{h} = \bar{h}(x) \quad , \tag{2.26}$$

the background wave field can be expressed analytically. Employing Snell's law, the phase function, S, is readily given as

$$S(x,y) = \beta y - \int^x \alpha \, dx \quad , \tag{2.27}$$

where

$$\alpha(x) = \bar{k} \cos\theta \quad ,$$

and

$$\beta = \bar{k}(x) \sin\theta = \bar{k}_o \quad \sin\theta_o \quad , \tag{2.28}$$

are the x- and y- components of the local wave number vector ($\vec{\bar{k}}(x)$, respectively, and $\theta(x)$ is the local angle of incidence (Figure 2.1). The subscript "o" denotes quantities at a location far away from the shoreline (x=0). Conservation of wave energy requires the local wave amplitude to be:

$$A(x) = A_o \left[\left(\frac{\bar{k}}{\bar{k}_o}\right) \left(\frac{\alpha_o}{\alpha}\right) \left(\frac{2\bar{k}_o\bar{h}_o + \sinh 2\bar{k}_o\bar{h}_o}{2\bar{k}\,\bar{h} + \sinh 2\bar{k}\,\bar{h}}\right)\right]^{1/2} \cdot \frac{\cosh \bar{k}\,\bar{h}}{\cosh \bar{k}_o\bar{h}_o} \quad . \tag{2.29}$$

As shown by Lozano and Liu (1980), the curvilinear coordinates (ρ,σ), representing the wave rays and phase lines, can be expressed as:

$$\rho = (y-y_o) + \int_{x_o}^{x} \tan\theta \, dx \quad , \tag{2.30}$$

$$\sigma = (y-y_o) - \int_{x_o}^{x} \cot\theta \, dx \quad , \tag{2.31}$$

where (x_o,y_o) is an arbitrary reference point. Substitutions of $h_\rho = \cos\theta$

and

$+h_\sigma = \sin\theta$, into (2.22), yield

$$\cot^2\theta \left(2i\beta + 2i\,\frac{V\omega}{G}\sin\theta + \frac{2}{A}\frac{\partial A}{\partial \sigma} + \frac{1}{G}\frac{\partial G}{\partial \sigma}\right)\frac{\partial F}{\partial \sigma}$$

$$+ \left(\frac{2iV\omega}{G}\cos\theta + \frac{2}{A}\frac{\partial A}{\partial \rho} + \frac{1}{G}\frac{\partial G}{\partial \rho} + \frac{2}{\sin 2\theta}\frac{\partial \theta}{\partial \rho}\right)\frac{\partial F}{\partial \rho}$$

$$+ \frac{\partial^2 F}{\partial \rho^2} + \frac{1}{G}\left[i\omega\,\nabla\cdot\vec{u} + i\omega\,W + G\,(k_1^2 - \bar{k}^2)\right.$$

$$\left. - 2\omega\,\vec{\bar{k}}\cdot\vec{u}\right] F = 0 \quad . \tag{2.32}$$

In the case of no ambient current, the corresponding parabolic equation for the corresponding parabolic equation for the diffraction factor becomes

$$\cot^2\theta \left(2i\beta + \frac{2}{A}\frac{\partial A}{\partial \sigma} + \frac{1}{G}\frac{\partial G}{\partial \sigma}\right)\frac{\partial F}{\partial \sigma} + \left(\frac{2}{A}\frac{\partial A}{\partial \rho} + \frac{1}{G}\frac{\partial G}{\partial \rho} + \frac{2}{\sin 2\theta}\frac{\partial \theta}{\partial \rho}\right)\frac{\partial F}{\partial \rho}$$

$$+ \frac{\partial^2 F}{\partial \rho^2} + \left(\hat{k}^2 + \frac{iW\omega}{G}\right)\cos^2\theta \, F = 0. \tag{2.33}$$

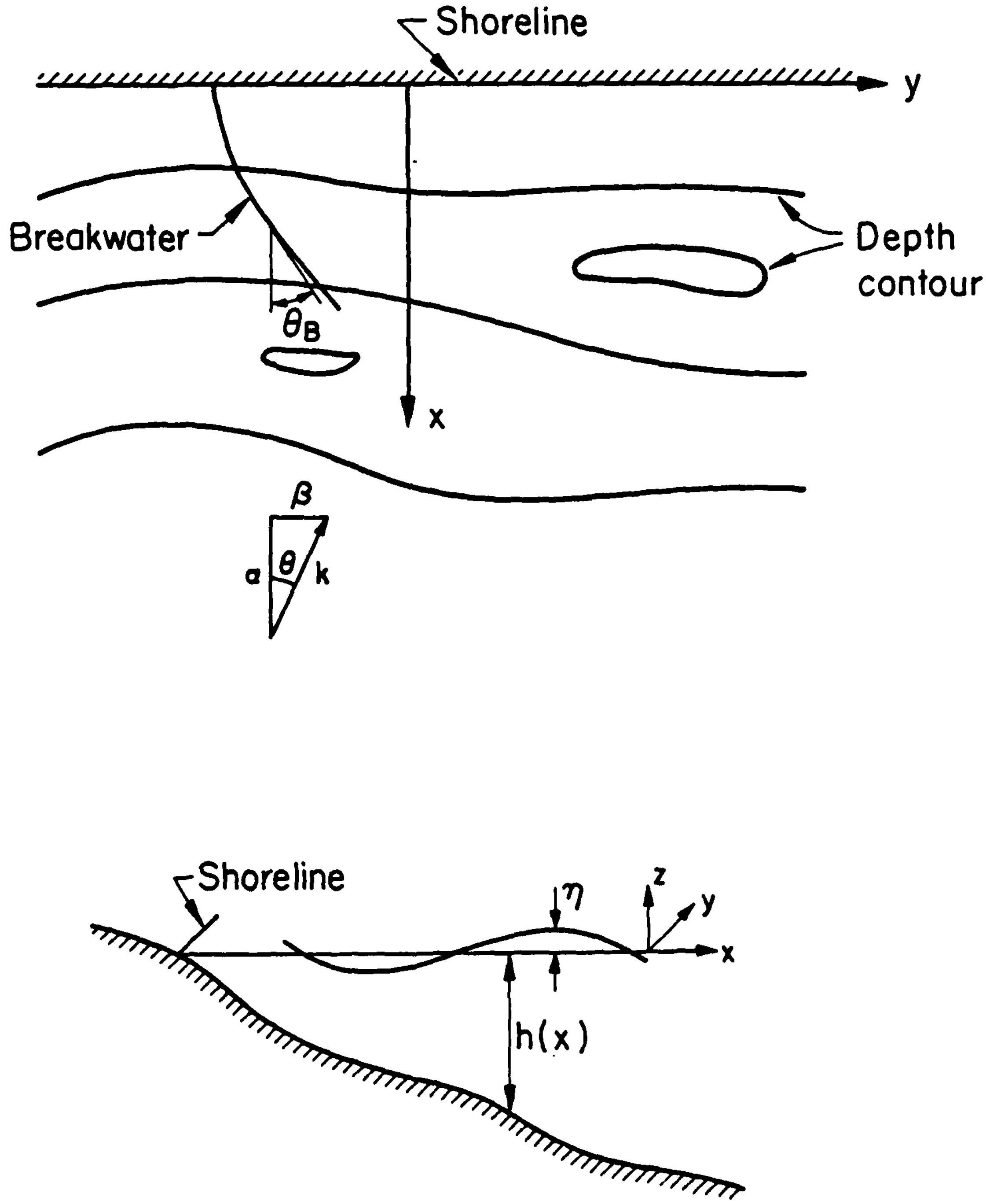


Figure 2.1 Definition Sketch and Coordinate System

Note that (2.33) reduces to the equation derived by Tsay and Liu (1982) if the derivatives of A and G and the energy dissipation term are ignored. A numerical scheme will be presented in section 2.4 to solve (2.32) and (2.33). We remark here the transformation given in (2.30) and (2.31) breaks down in the case of normal incidence, $\theta = 0^0$. Alternatives are presented in section 2.5 and 2.6.

2.3 A Numerical Algorithm for Generating the Modified Topography

To apply the parabolic approximation method described in the previous section, we must first develop a scheme for generating the modified topography $\bar{h}(x)$. Usually, the topographical data are obtained from either direct field measurements or digitization of depth contour maps. Consequently, the depth is given at each node of an irregular mesh as shown in Figure 2.2. The modified topography can be generated by the following method:

1. Along each alongshore cross section $x = x_i$ $(i = 1,2,3,\ldots,M)$ there are N nodes and the depth at each node is denoted as h_j $(j = 1,2,3,\ldots N)$. An averaged depth along a cross section can be computed as

$$h(x_i) = \frac{1}{2} \sum_{j=1}^{N-1} \frac{(y_{j+1} - y_j)\,(h^i_{j+1} + h^i_j)}{(y_N - y_1)} \quad , \; i = 1,2,\ldots,M \qquad (2.34)$$

where y_j is the y coordinate for the j-th node along the cross section. Note that the averaging process is being weighted by the distance between two adjacent nodes.

2. The modified topography $\bar{h}(x)$ is obtained by the cubic spline approximation (Conte, 1965), i.e.

$$h(x) = \sum_{k=1}^{4} C_{k,i}\,(x-x_i)^{k-1} \qquad , \; i=1,2,\ldots,M-1 \qquad (2.35)$$

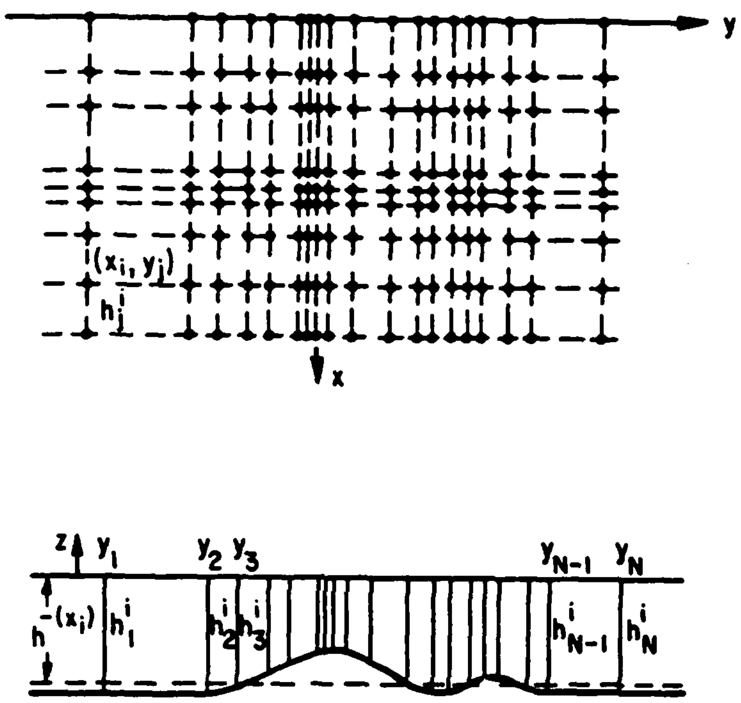


Figure 2.2 Grid Mesh for Digitized Depth and Average Depth

where the coefficients $C_{k,i}$ are determined by matching $\bar{h}(x)$ with the average water depth $h(x_i)$ along each cross section x_i and by requiring the first and second derivatives of (2.34) to be continuous at each node x_i.

2.4 A Numerical Scheme for Solving the Parabolic Wave Equation

The parabolic wave equation (2.32) is solved by a finite-difference method (Smith, 1978). Since the equation is discretized on the ρ - σ plane a rectangular grid system is used (Figure 2.3). If $F(n\Delta\rho, m\Delta\sigma) = F_n^m$ denotes the diffraction factor at the nodes, (2.32) can be rewritten in the following finite-difference form:

$$\cot^2\theta\ (2i\beta + a_1 + a_2 + a_3)\ (F_n^{m+1} - F_n^m) + r\ (b_1 + b_2 + b_3 + b_4)$$
$$[w\ (F_{n+1}^{m+1} - F_{n-1}^{m+1}) + (1 - w)\ (F_{n+1}^m - F_{n-1}^m)] + r\ [w\ \delta^2\ F_n^{m+1} +$$
$$(1 - w)\ \delta^2\ F_n^m] + w\ Q_n^{m+1}\ F_n^{m+1} + (1 - w)\ Q_n^{m+1}\ F_n^m = 0 \quad , \qquad (2.36)$$

where

$$\delta^2\ F_n^m = F_{n-1}^m - 2\ F_n^m + F_{n+1}^m \quad ,$$

$$r = \Delta\sigma/(\Delta\rho)^2 \quad ,$$

$$Q = \frac{\Delta\sigma\ \cos^2\theta}{G}\ [i\omega\ \nabla\cdot\vec{u} + i\omega W + G\ (k_1^2 - \bar{k}^2) - 2\omega\ \vec{\bar{k}}\cdot\vec{u}] \quad ,$$

$$a_1 = \frac{4}{A_n^{m+1} + A_n^m}\ \left(\frac{A_n^{m+1} - A_n^m}{\Delta\sigma}\right) \quad ,$$

$$a_2 = \frac{2}{G_n^{m+1} + G_n^m}\ \left(\frac{G_n^{m+1} - G_n^m}{\Delta\sigma}\right) \quad ,$$

$$a_3 = 2i\ \frac{U_n^{m+1}}{G_n^{m+1}}\omega \sin\theta \quad ,$$

$$b_1 = \frac{1}{A_n^m}\ (A_n^m - A_{n-1}^m) \quad ,$$

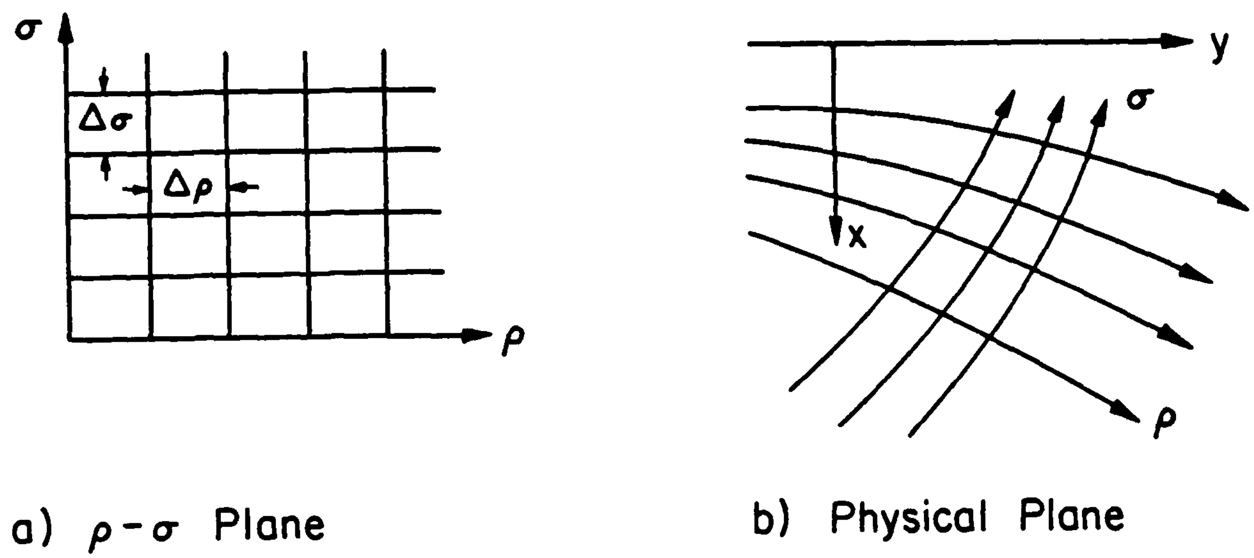


Figure 2.3 Relationship between Physical Coordinates and Curvilinear Coordinates

$$b_2 = \frac{1}{2\ G_n^m} [G_n^m - G_{n-1}^m] \qquad ,$$

$$b_3 = \frac{1}{\sin 2\theta} (\theta_n^{m+1} - \theta_{n-1}^{m+1}) \qquad ,$$

$$b_4 = 2i \frac{V_n^{m+1} \omega}{G_n^{m+1}} \cos\theta \qquad , \qquad (2.37)$$

and w is a weighting factor which positions the value of F and the derivative of F with respect to Ω, between $m\Delta\sigma$ and $(m+1)\Delta\sigma$. In (2.36) and (2.37) the unspecified values of θ are evaluated at θ_n^{m+1}. The finite differences method is constructed based on taking forward differences in the wave propagation direction (σ-direction) and central differences in the ρ-direction. The scheme reduces to the well-known Crank-Nicolson method when the weighting factor, w, is 0.5. The finite difference scheme is unconditionally stable if the weighting factor is greater than or equal to 0.5 (Lax and Richtmyer, 1956). In the case where the ambient current is zero, the finite-difference equation, (2.36), still holds. The coefficients a_3 and b_4 become zero, and Q term in (2.36) is redefined as

$$Q = \frac{\Delta\sigma \cos^2\theta}{G} [i\omega W + Gk^2] \qquad (2.38)$$

A computer program was written to solve (2.36) with appropriate boundary and initial conditions. Solutions are first obtained on the ρ-σ plane and are then converted onto the physical x-y plane through the coordinate transformation, (2.30) and (2.31). Although an efficient numerical scheme has been developed to perform the coordinate transformation, a significant amount of computing time is still required for nearly normal incidence. As pointed out before the transformation breaks down at normal incidence. To remedy this shortcoming, two approximated approaches are introduced in the following

sections. The advantages and disadvantages of these approaches will be discussed in section 3.

2.5 Approximation Using a Rotated Cartesian Coordinate System

The first approximate model adopts the following coordinate system transformation:

$$\rho = (y - y_o) \cos \theta_o + (x - x_o) \sin \theta_o \qquad ,$$

$$\sigma = (y - y_o) \sin \theta_o - (x - x_o) \cos \theta_o \qquad , \tag{2.39}$$

where θ_o is a reference angle at a reference point, (x_o, y_o) (Figure 2.4). The angle θ_o is preferably chosen as the angle of wave incidence at the seaward extent of the computational domain. The coordinates (ρ, σ) represent a rotated Cartesian system; the σ - axis coincides with the direction of incident wave propagation. Because the local angle of incidence becomes smaller as waves propogate toward the shoreline, the difference between (2.39) and the curvilinear coordinate described by (2.30) and (2.31) becomes significant when θ_o is large and when waves propagate into shallower water.

Applying the parabolic approximation to (2.21) with (2.39) and $h_\sigma = h_\rho = 1$, we obtain

$$\left(2i\bar{k} \cos\bar{\theta} + \frac{2iU\omega}{G} + \frac{2}{A}\frac{\partial A}{\partial \sigma} + \frac{1}{G}\frac{\partial G}{\partial \sigma}\right)\frac{\partial F}{\partial \sigma} + \left(2i\bar{k} \sin \bar{\theta} + \frac{2iV\omega}{G} + \frac{2}{A}\frac{\partial A}{\partial \rho} + \frac{1}{G}\frac{\partial G}{\partial \rho}\right)\frac{\partial F}{\partial \rho} + \frac{\partial^2 F}{\partial \rho^2} + \frac{1}{G}\left[i\omega\nabla \cdot \vec{u} + i\omega W + G(k_1^2 - \bar{k}^2) - 2\omega\vec{\bar{k}} \cdot \vec{u})\right] F = 0 \tag{2.40}$$

where $\bar{\theta} = \theta - \theta_o$ is the angle between directions of local incidence and wave incidence along the initial computational line. By using the same finite difference approximations as those given in section 2.4, (2.40) can be discretized in the following form:

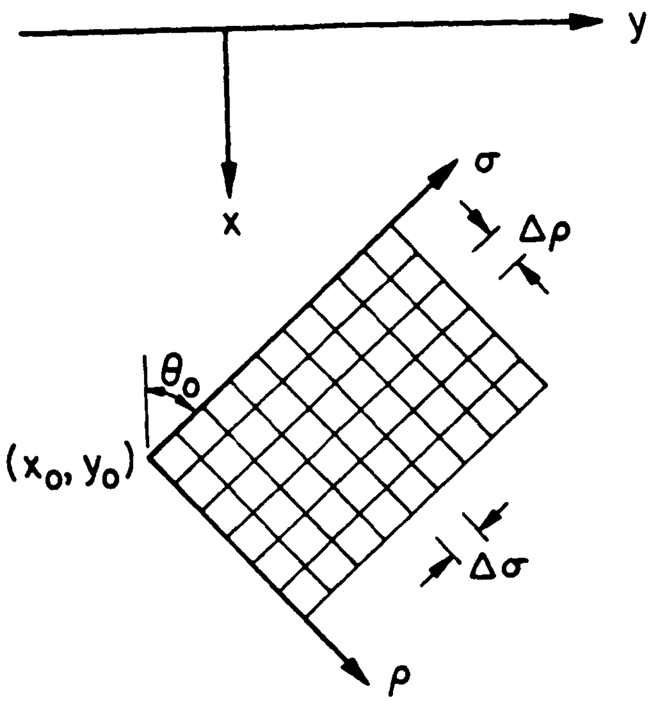


Figure 2.4 Relationship between Physical Coordinates and Rotated Cartesian Coordinates

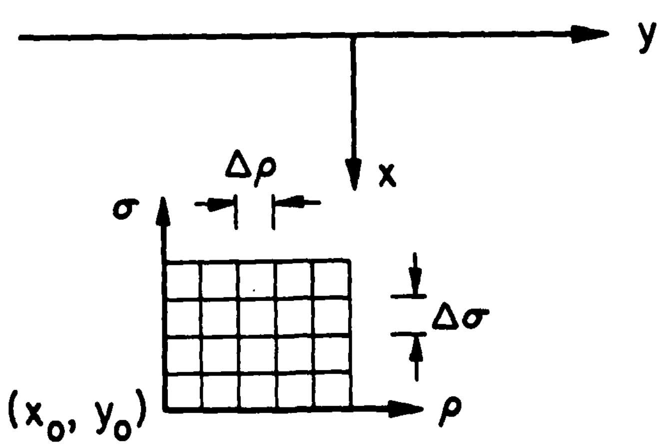


Figure 2.5 Relationship between Physical Coordinates and Fixed Cartesian Coordinates

$$(2i\bar{k} \cos \bar{\theta} + a_1 + a_2 + a_3)\ (F_n^{m+1} - F_n^m) + r\ (i\bar{k} \sin \bar{\theta} + b_1 + b_2 + b_4)$$
$$[w\ (F_{n+1}^{m+1} - F_{n-1}^{m+1}) + (1 - w)\ (F_{n+1}^m - F_{n-1}^m)] + r\ [w\ \delta^2\ F_n^{m+1} + (1-W)\ \delta^2\ F_n^m] + w\ Q_n^{m+1}\ F_n^{m+1}$$
$$+ (1 - w)\ Q_n^{m+1}\ F_n^m = 0 \quad , \tag{2.41}$$

where a_1, a_2, a_3, b_1, b_2, and b_4 are again defined by (2.37).

2.6 Approximation Using a Fixed Cartesian Coordinate System

The second approximate model uses the regular Cartesian coordinate with σ-axis pointing toward the shoreline (Figure 2.5), i.e.

$$\sigma = x_o - x \quad ,$$
$$\rho = y - y_o \quad . \tag{2.42}$$

The second approximation approaches the first approximation, (2.39), when the angle of incidence, θ_o, becomes very small. Equation (2.22) can now be reduced as:

$$(2i\bar{k} \cos\theta + \frac{2iU\omega}{G} + \frac{2}{A}\frac{\partial A}{\partial \sigma} + \frac{1}{G}\frac{\partial G}{\partial \sigma})\frac{\partial F}{\partial \sigma} + (2i\bar{k} \sin\theta\ \frac{1}{G}\frac{\partial G}{\partial \rho} + \frac{2iV\omega}{G})\frac{\partial F}{\partial \rho} + \frac{\partial^2 F}{\partial \rho^2}$$
$$+ \frac{1}{G}\ [i\omega\nabla \cdot \vec{u} + i\omega W + G(k_1^2 - \bar{k}^2\ ) - 2\omega\ \vec{\bar{k}} \cdot \vec{u}]\ F = 0. \tag{2.43}$$

The background amplitude, A, is a constant along a contour line parallel to the shoreline, i.e. $\partial A/\partial \rho = 0$. The finite difference representation of (2.43) can be written as:

$$(2i\bar{k} \cos\theta + a_1 + a_2 + a_3)\ (F_n^{m+1} - F_n^m) + r\ (i\bar{k} \sin\theta + b_2 + b_4)\ [w\ (F_{n+1}^{m+1} -$$
$$F_{n-1}^{m+1}) + (1 - w)\ (F_{n+1}^m - F_{n-1}^m)] + r\ [w\ \delta^2\ F_n^{m+1} + (1 - w)\ \delta^2\ F_n^m] +$$
$$w\ Q_n^{m+1}\ F_n^{m+1} + (1 - w)\ Q_n^{m+1}\ F_n^m = 0. \tag{2.44}$$

Since the coordinate system used in this approximation does not depend on the angle of incidence, a single grid system can be used for a wide range of

angles of incidence. The error of the parabolic approximation may become significant, when the angle of incidence, θ_o, becomes large. The accuracy of the approximate models is discussed in section 3.

2.7 Boundary Conditions

To solve the finite difference equation, (2.36), (2.41) or (2.44), lateral and initial boundary conditions must be prescribed. Since the numerical model is designed to study wave propagation in an open coastal region, the topography is assumed to be uniform in the alongshore direction far away from the region of interest, i.e., as $y \to \pm \infty$. Therefore, the boundary condition along the lateral boundaries, $\rho = \rho_a$ and $\rho = \rho_b$, requires

$$F = 1 \qquad \text{at } \rho = \rho_a \text{ and } \rho_b \quad , \tag{2.45}$$

or

$$\frac{\partial F}{\partial \rho} = 0 \qquad \text{at } \rho = \rho_a \text{ and } \rho_b \quad . \tag{2.46}$$

Although (2.46) is a further simplification of (2.45), numerical results, using (2.45) or (2.46), do not differ significantly as long as the computational domain is large.

Inside the computational domain, breakwaters may be installed. These breakwaters are represented by straightline segments without thickness. Along both sides of a breakwater no-flux boundary conditions, $\vec{n} \cdot \nabla\phi = 0$ are applied, where $\vec{n}$ is the unit normal along the breakwater. Using (2.14) and applying the parabolic approximation, one can derive an approximate boundary condition along a breakwater (Tsay and Liu, 1984):

$$\frac{\partial F}{\partial \rho} + C_B F = 0 \quad , \tag{2.47}$$

where

$$C_B = i\bar{k}\sin\theta \frac{\cot\theta \tan\theta_B + 1}{1 - \tan\theta \tan\theta_B} , \tag{2.48}$$

for the curvilinear coordinate system;

$$C_B = i\bar{k}\frac{\sin(\theta+\theta_B)}{\cos(\theta_o+\theta_B)} , \tag{2.49}$$

for the rotated Cartesian coordinate system, and

$$C_B = i\bar{k}\frac{\sin(\theta+\theta_B)}{\cos\theta_B} \tag{2.50}$$

for the fixed Cartesian coordinate system. The angles θ and θ_B are the local incident wave angle and the inclination angle of the breakwater, respectively. As shown in Figure 2.1, θ_B is between $+\pi/2$ and $-\pi/2$.

The appearance of a breakwater divides the computational line into two separate parts and grid points do not necessarily fall the solid boundary (Figure 2.6). The boundary condition, (2.47) must be evaluated separately at point j' (Lin, 1986). Using Taylor's series expansion, the quantity $F_{j'}$ can be evaluated as

$$\begin{aligned} F_{j'} &= F_{j-1} + \frac{\partial F_{j-1}}{\partial \rho}\Delta\rho_1 + O(\Delta\rho_1^2) \\ &= F_{j-1} + \frac{F_j - F_{j-2}}{2\Delta\rho}\Delta\rho_1 + O(\Delta\rho^2, \Delta\rho_1^2) \end{aligned} \tag{2.51}$$

$$\begin{aligned} \left(\frac{\partial F}{\partial \rho}\right)_{j'} &= \frac{\partial F_{j-1}}{\partial \rho} + \frac{\partial^2 F_{j-1}}{\partial \rho^2}\Delta\rho_1 + O(\Delta\rho_1^2) \\ &= \frac{F_j - F_{j-2}}{2\Delta\rho} + \frac{F_j - 2F_{j-1} + F_{j-2}}{\Delta\rho^2}\Delta\rho_1 + O(\Delta\rho^2, \Delta\rho_1^2) \end{aligned} \tag{2.52}$$

Substitution of (2.51) and (2.52) into (2.47) yields

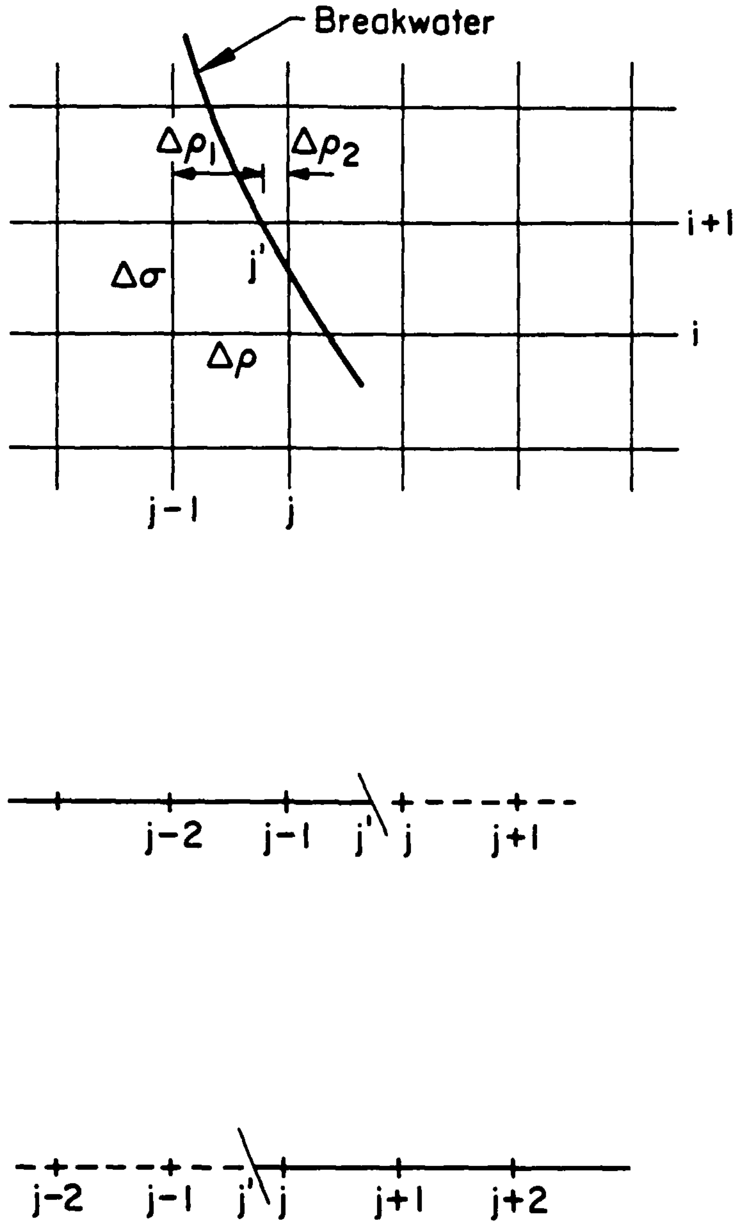


Figure 2.6 Numerical Approximation for a Solid Boundary

$$F_j = \frac{4\Delta\rho_1 - 2C_B\Delta\rho^2}{2\Delta\rho_1 + \Delta\rho + C_B\Delta\rho_1\Delta\rho} F_{j-1} + \frac{\Delta\rho - 2\Delta\rho_1 + C_B\Delta\rho_1\Delta\rho}{2\Delta\rho_1 + \Delta\rho + C_B\Delta\rho_1\Delta\rho} F_{j-2} \tag{2.53}$$

For the expanding computational domain on the left-hand side of the breakwater, F_{j+1} may be needed in addition to F_j. It may be extrapolated from F_{j-1} and F_j by first order approximation.

$$F_{j+1} = 2F_j - F_{j-1} \tag{2.54}$$

Similarly, on the right-hand side of the breakwater

$$\begin{aligned} F_{j'} &= F_j - \frac{\partial F_j}{\partial \rho} \Delta\rho_2 + O(\Delta\rho_2^2) \\ &= F_j - \frac{F_{j+1} - F_{j-1}}{2\Delta\rho} \Delta\rho_2 + O(\Delta\rho^2, \Delta\rho_1^2) \end{aligned} \tag{2.55}$$

$$\begin{aligned} \left(\frac{\partial F_j}{\partial \rho}\right)_{j'} &= \frac{\partial F_j}{\partial \rho} - \frac{\partial^2 F_j}{\partial \rho^2} \Delta\rho_2 + O(\Delta\rho_2^2) \\ &= \frac{F_{j+1} - F_{j-1}}{2\Delta\rho} - \frac{F_{j+1} - 2F_j + F_{j-1}}{\Delta\rho^2} \Delta\rho_2 + O(\Delta\rho^2, \Delta\rho_2^2) \end{aligned} \tag{2.56}$$

Substitution of (2.55) and (2.56) into (2.47) yields

$$F_{j-1} = \frac{4\Delta\rho_2 + 2C_B\Delta\rho^2}{\Delta\rho + 2\Delta\rho_2 - C_B\Delta\rho\Delta\rho_2} F_j + \frac{\Delta\rho - 2\Delta\rho_2 - C_B\Delta\rho\Delta\rho_2}{\Delta\rho + 2\Delta\rho_2 - C_B\Delta\rho\Delta\rho_2} F_{j+1} \tag{2.57}$$

F_{j-2} may be approximated by first order extrapolation from F_j and F_{j-1} as

$$F_{j-2} = 2F_{j-1} - F_j \tag{2.58}$$

The present finite-difference method allows that the number of nodal points on each side of breakwater to increase by one at each marching step. To avoid the instability created by the boundary condition, the following condition should be satisfied (Tsay and Liu, 1984):

$$|C_B \Delta\rho| < 1 \tag{2.59}$$

An initial boundary condition is usually prescribed along a line where the wave amplitude can be determined by using linear wave ray theory. Therefore, the diffraction factor will be equal to one;

$$F = 1 \qquad \text{at} \qquad \sigma = 0 \quad . \tag{2.60}$$

The implementation of the boundary conditions (2.45) and (2.60) in a finite difference form is straight-forward, while central difference discretization is used to approximate (2.46).

2.8 Energy Dissipation

When waves propagate into shallow water, energy dissipation caused by bottom friction and wave breaking may become important. To incorporate these energy dissipation effects into the parabolic approximation method, analytical expressions for W must be specified.

Various analytical expressions of W have been proposed for different physical phenomena. If the energy dissipation caused by a turbulent boundary layer is of concern, the function W may be written as (Liu and Tsay, 1985):

$$W = \frac{16}{3\pi} f \frac{k^2 C_g \, |\eta|}{\sinh kh \, (2kh + \sinh 2kh)} \tag{2.61}$$

where f is a friction factor. Note that because W is proportional to the diffraction factor, F, the term representing the energy dissipation in the governing equation is nonlinear in F. In the numerical computations, either an iterative scheme must be used or this term is linearized. The simplest approach is to use the local wave amplitude $|FA|$ from the previous computational line in (2.61).

In the case of breaking waves, an empirical wave height decay model has been suggested by Dally, Dean and Dalrymple (1984). In terms of the

dissipation function W, the decay model can be written as

$$W = \frac{K\ C_g}{h} \left(1 - \frac{\gamma^2 h^2}{4|\eta|^2}\right) \tag{2.62}$$

where K and γ are empirical constants. Calibrating with laboratory data, Dally, Dean and Dalrymple (1984) suggested that $K = 0.15$ and $\gamma = 0.4$ should be used. Of course (2.62) is valid only after waves start to break, i.e. $|\eta|/h > 0.4$. Waves stop breaking when $|\eta|/h < 0.2$ and W becomes zero. Once again, the W given in (2.62) is nonlinear in the free surface displacement. In the computations W is linearized by using η-values from the previous computational line.

3. MODEL VERIFICATION

The numerical scheme presented in the previous section was verified with several sets of laboratory and field data. In the case where the ambient current is zero and a breakwater does not exist, refraction and diffraction is caused entirely by the bathymetry. Three sets of data were used to investigate the model accuracy for this case: (1) laboratory measurements of normally incident waves propagating over a submerged shoal on an otherwise constant depth (Maruyama 1981), (2) wave basin measurements of obliquely incident waves propagating over a submerged shoal on a sloping beach (Berkhoff et al. 1982), and (3) field measurements of wave propagation over varying topography (Ebersole, et al. 1986). Laboratory data of wave amplitudes in the neighborhood of shore-connected breakwaters (Hales 1980, Isobe 1986) was also used to verify the capability of the model in dealing with cases involving multiple breakwaters.

3.1 Normally Incident Waves Propagating Over a Submerged Shoal

Experimental data for wave propagation over a submerged shoal were obtained in a wave tank as shown in Figure 3.1 (Maruyama 1981). Water depths in the tank are given by the following expression:

$$h = h_o = 0.43\text{m} \qquad \text{for } r = \sqrt{(x-x_c)^2 + (y-y_c)^2} > r_1 = 1.25\text{m};$$

$$h = -z_c - [R^2 - (x - x_c)^2 - (y - y_c)^2]^{1/2}, \text{ for } r \le r_1, \qquad (3.1)$$

where r is a radial distance measured from the shoal center, r_1 is the radius of the shoal, h_o is the depth in the constant depth region of the tank, (x_c, y_c, z_c) = (10m, 2.5m, -2.884m) denotes the coordinate of the center of the shoal and R = 2.754m.

Because the incident angle is 0^0, rotated Cartesian coordinates given in

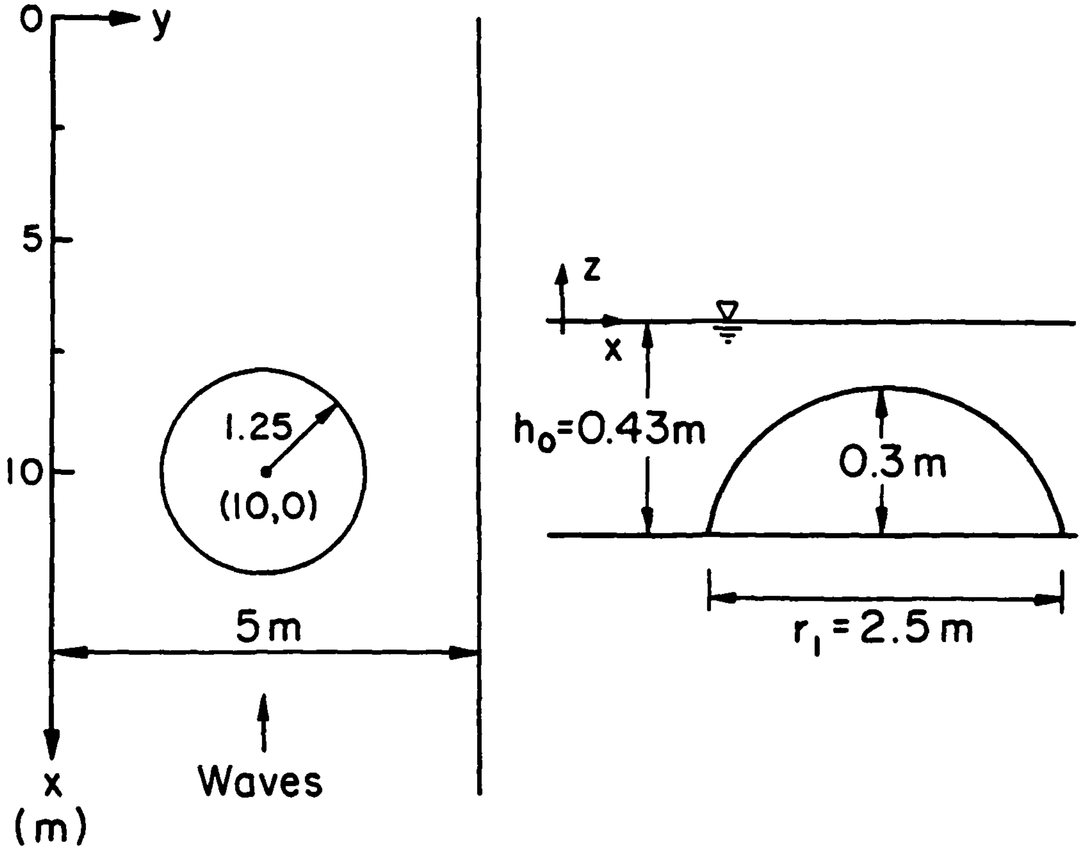


Figure 3.1 Sketch of the Geometry of a Submerged Shoal on a Constant Depth

(2.39) become the same as the fixed Cartesian coordinates given in (2.42). The fixed coordinate was used in these tests. Furthermore, due to the symmetry properties of the experimental set-up, numerical results are presented for only half of the tank. Model results are compared with measured data to investigate the validity of the model. Also, the effect of varying grid sizes on the solution are investigated in this series of tests. The combinations of grid sizes used to simulate case 1 where $T = 1.79$ sec., $H = 4.85$ cm and $h_o = 0.5$m are given in Table 3.1. The corresponding wavelength in the constant water depth region is 3.54m. Therefore, the largest grid size (0.5m) is about 1/7 of the wavelength; and since the diameter of the shoal is 2.5m there are less than five points representing cross sections of the submerged shoal for this grid size.

CASE	Δx(m)	Δy(m)	CPU(hr)
a	0.1	0.1	0.02
b	0.1	0.2	0.02
c	0.1	0.5	0.01
d	0.2	0.1	0.01
e	0.2	0.2	0.00
f	0.2	0.5	0.00
g	0.5	0.1	0.01
h	0.5	0.2	0.00
i	0.5	0.5	0.00

Table 3.1. Grid sizes for numerical experiments

Numerical results along the cross sections $x = 7$m and 9m, as well as $y = 2.5$m (centerline of the wave tank) are shown in Figure 3.2. For comparison

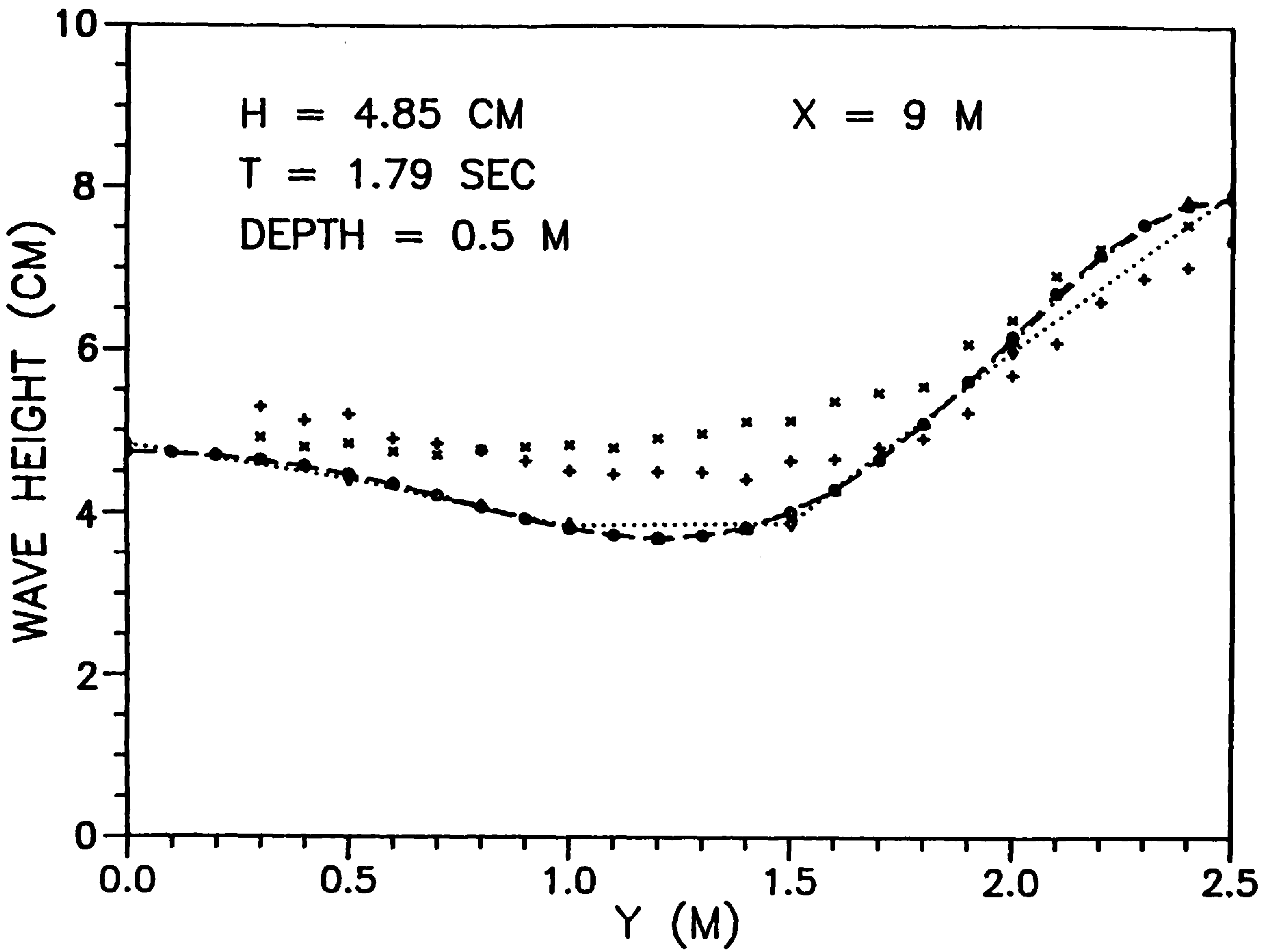


Figure 3.2a Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o $\Delta x=\Delta y=0.1m$, Δ-·-Δ-·-Δ , $\Delta x=0.1m$, $\Delta y=0.2m$; ···◇··· , $\Delta x=0.1m$, $\Delta y=0.5m$.

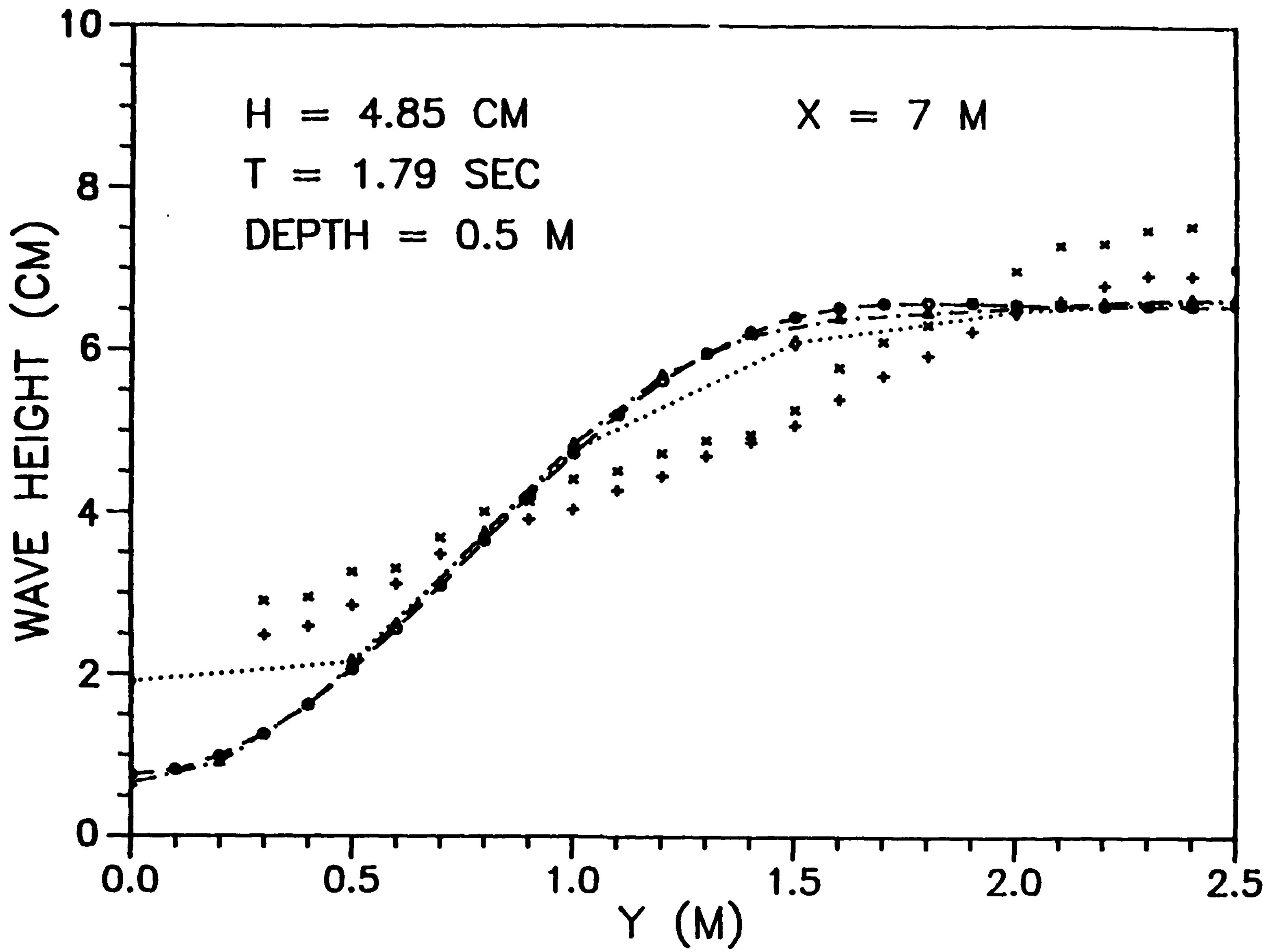


Figure 3.2b Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o $\Delta x=\Delta y=0.1m$, Δ-·-Δ-·-Δ, $\Delta x=0.1m$, $\Delta y=0.2m$; ···◇··· , $\Delta x=0.1m$, $\Delta y=0.5m$.

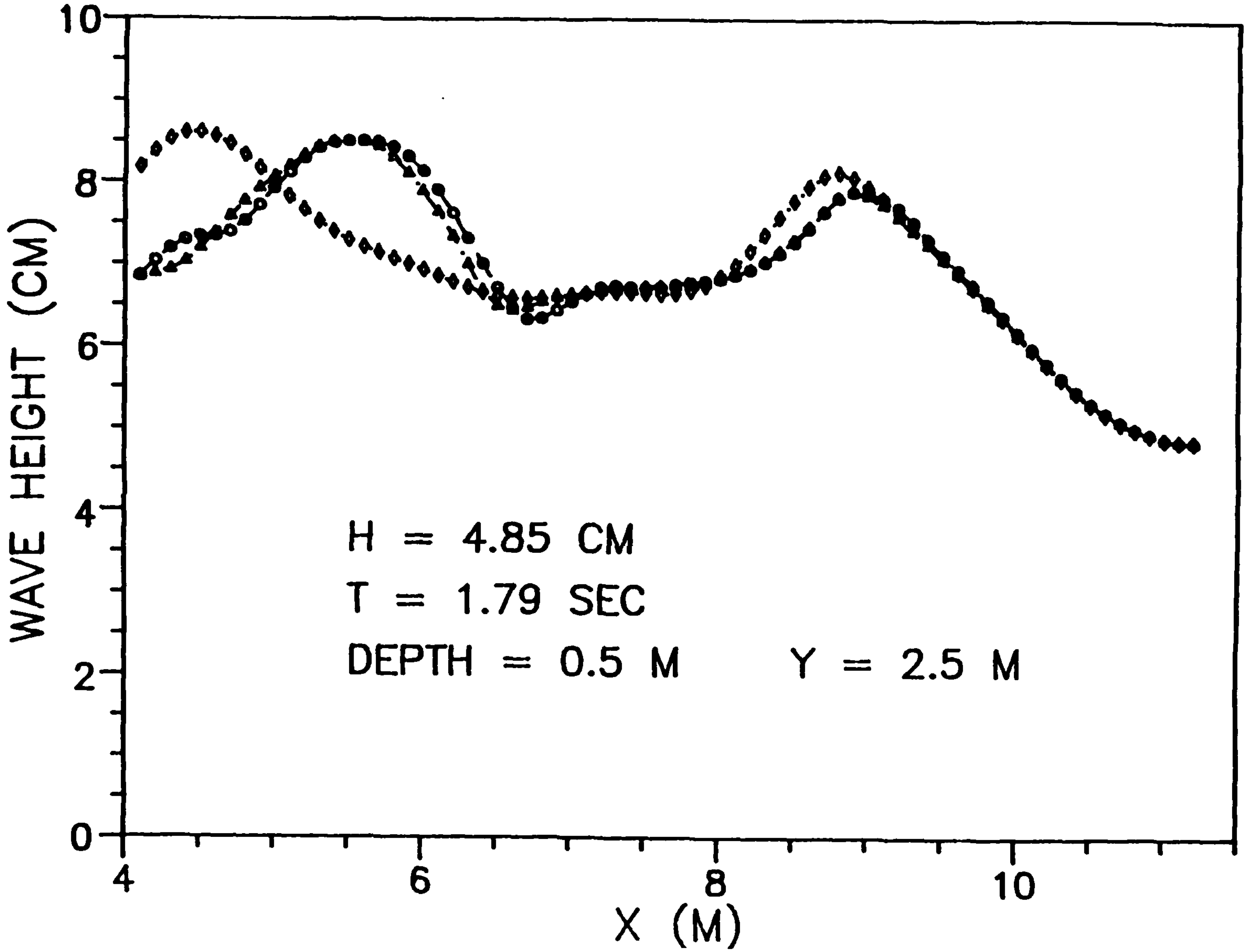


Figure 3.2c Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o $\Delta x=\Delta y=0.1m$, Δ-··-Δ-··-Δ, $\Delta x=0.1m$, $\Delta y=0.2m$; ···$\Diamond$··· , $\Delta x=0.1m$, $\Delta y=0.5m$.

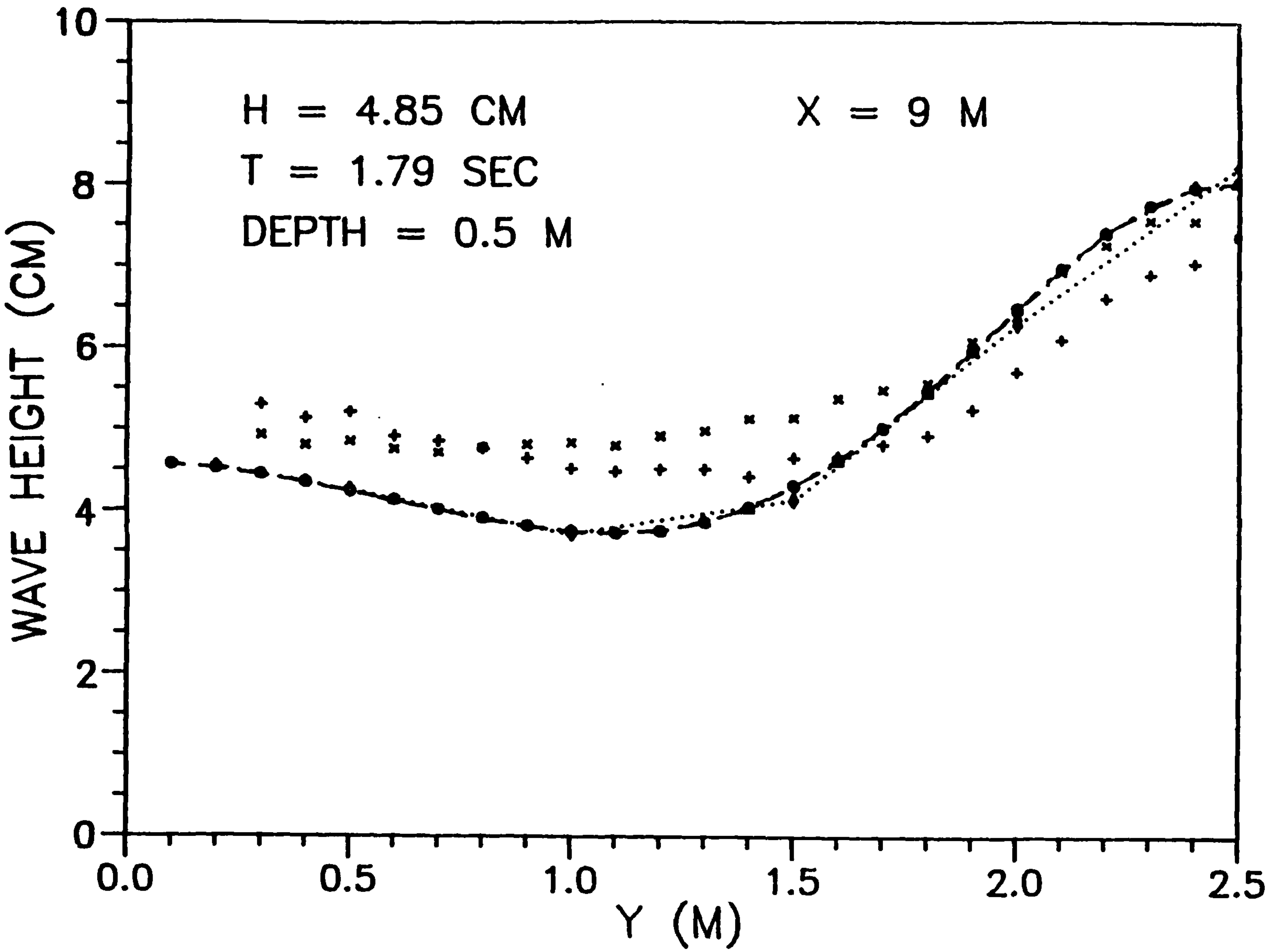


Figure 3.2d Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o Δx=0.2m, Δy=0.1m, Δ-·-Δ-·-Δ Δx=Δy=0.2m, ···$\Diamond$··· Δx=0.2m, Δy=0.5m.

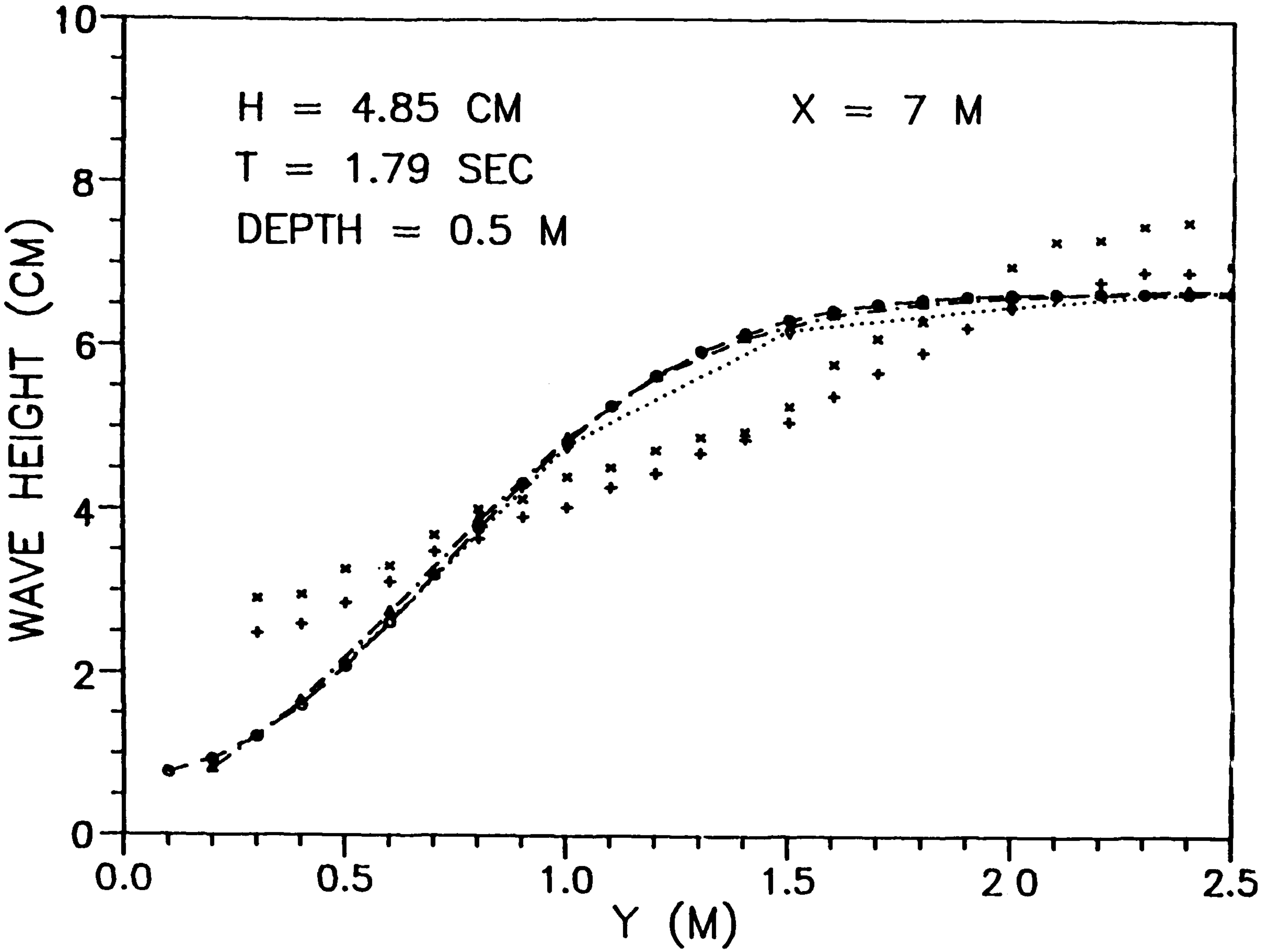


Figure 3.2e Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o Δx=0.2m, Δy=0.1m, Δ---Δ---Δ Δx=Δy=0.2m, ···◇··· Δx=0.2m, Δy=0.5m.

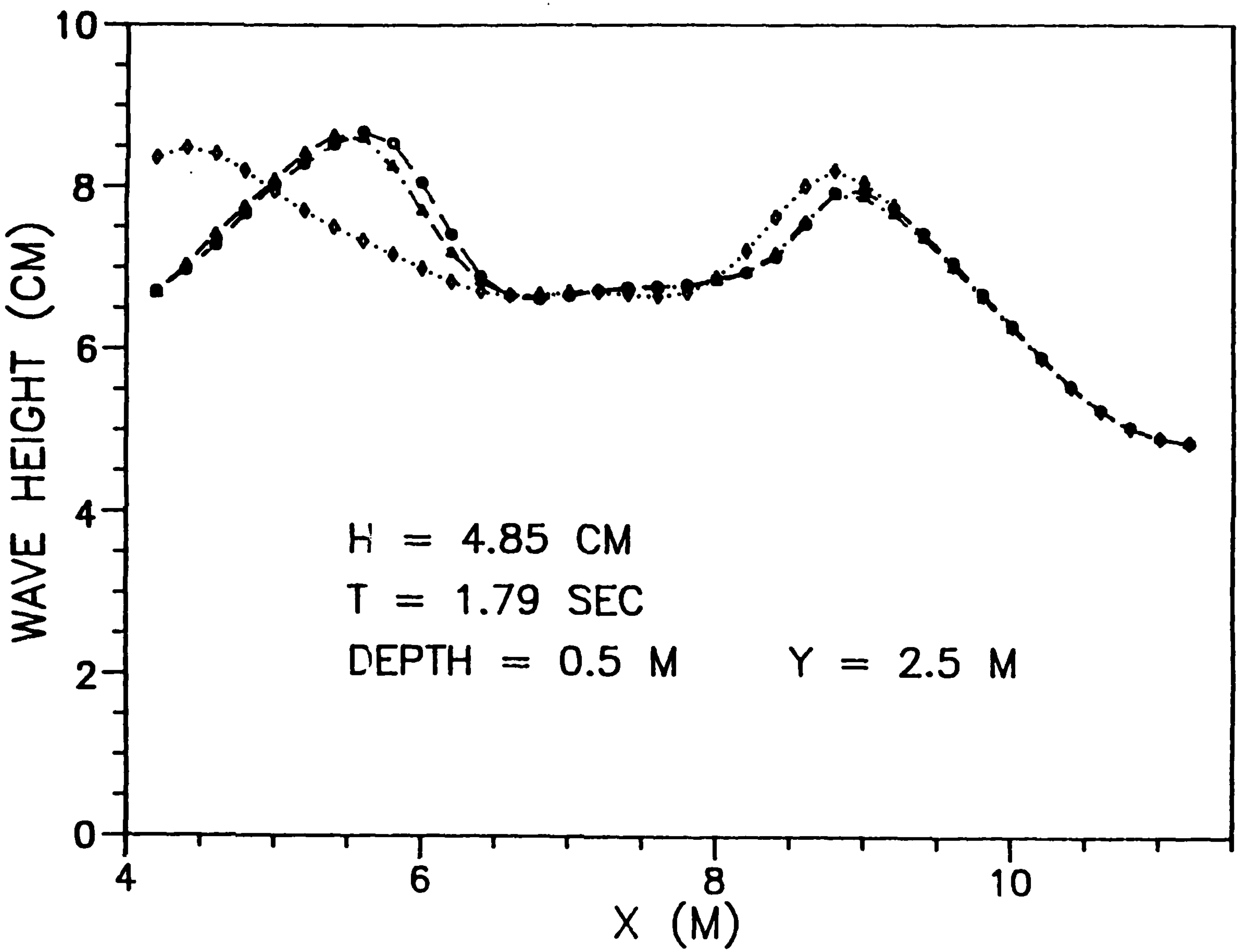


Figure 3.2f Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o Δx=0.2m, Δy=0.1m, Δ-·-Δ-·-Δ $\Delta x=\Delta y$=0.2m, ···◇··· Δx=0.2m, Δy=0.5m.

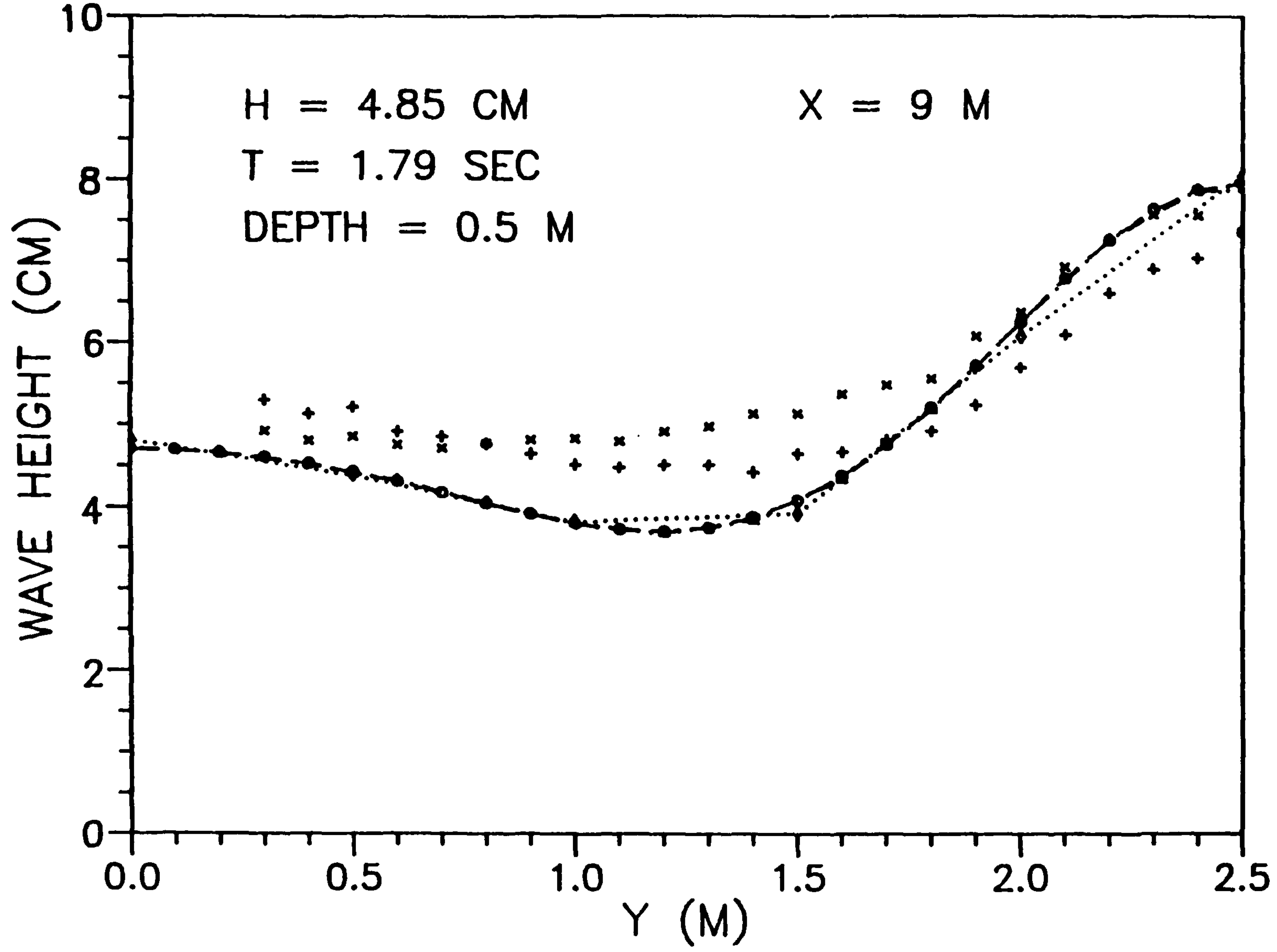


Figure 3.2g Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o, Δx=0.5 m, Δy=0.1m, Δ---Δ---Δ, Δx=0.5m, Δy=0.2m, ···◇··· , Δx= Δy=0.5m.

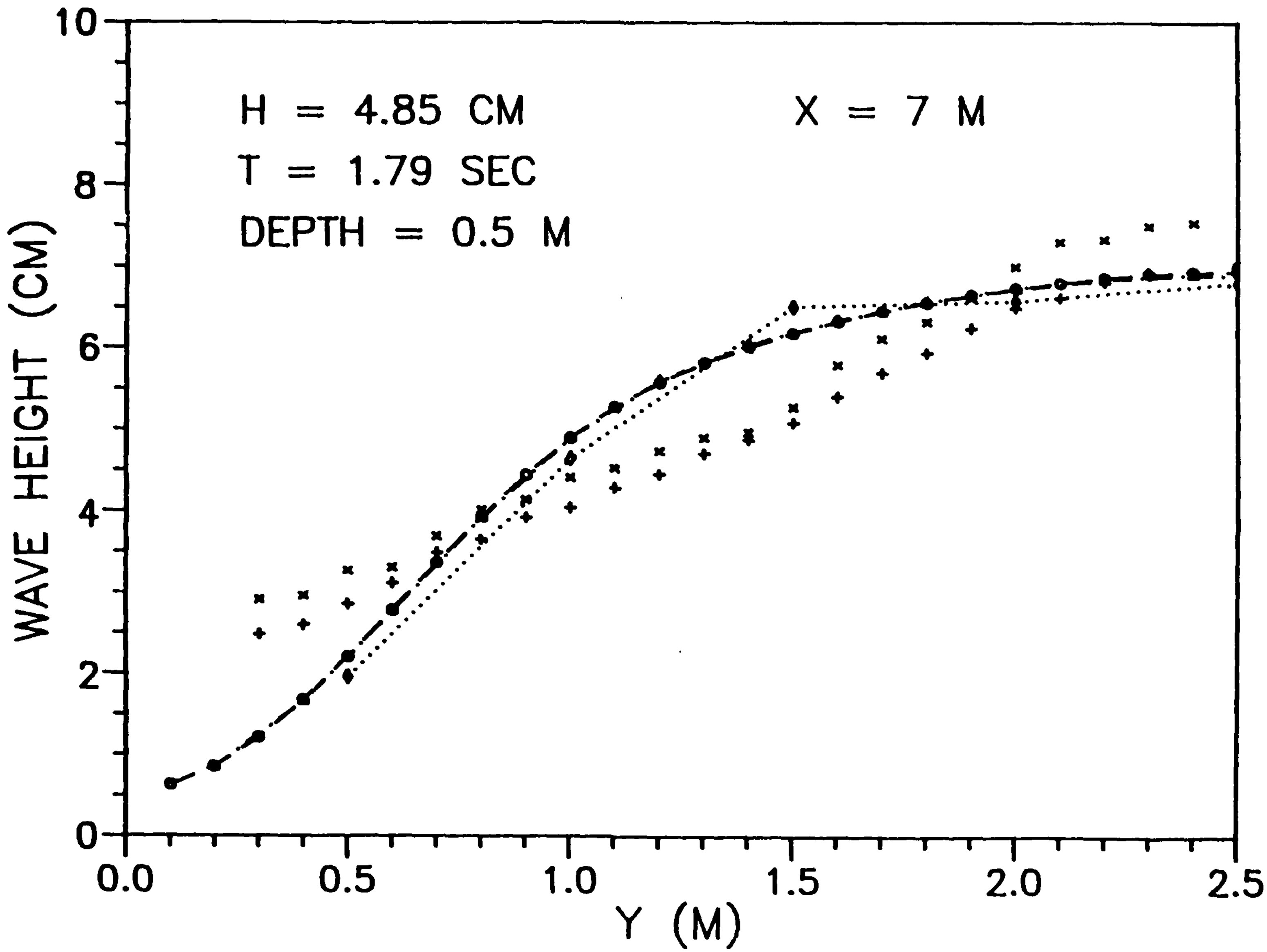


Figure 3.2h Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o, $\Delta x=0.5$ m, $\Delta y=0.1$m, Δ-·-Δ-·-Δ, $\Delta x=0.5$m, $\Delta y=0.2$m, ···◇··· $\Delta x= \Delta y=0.5$m.

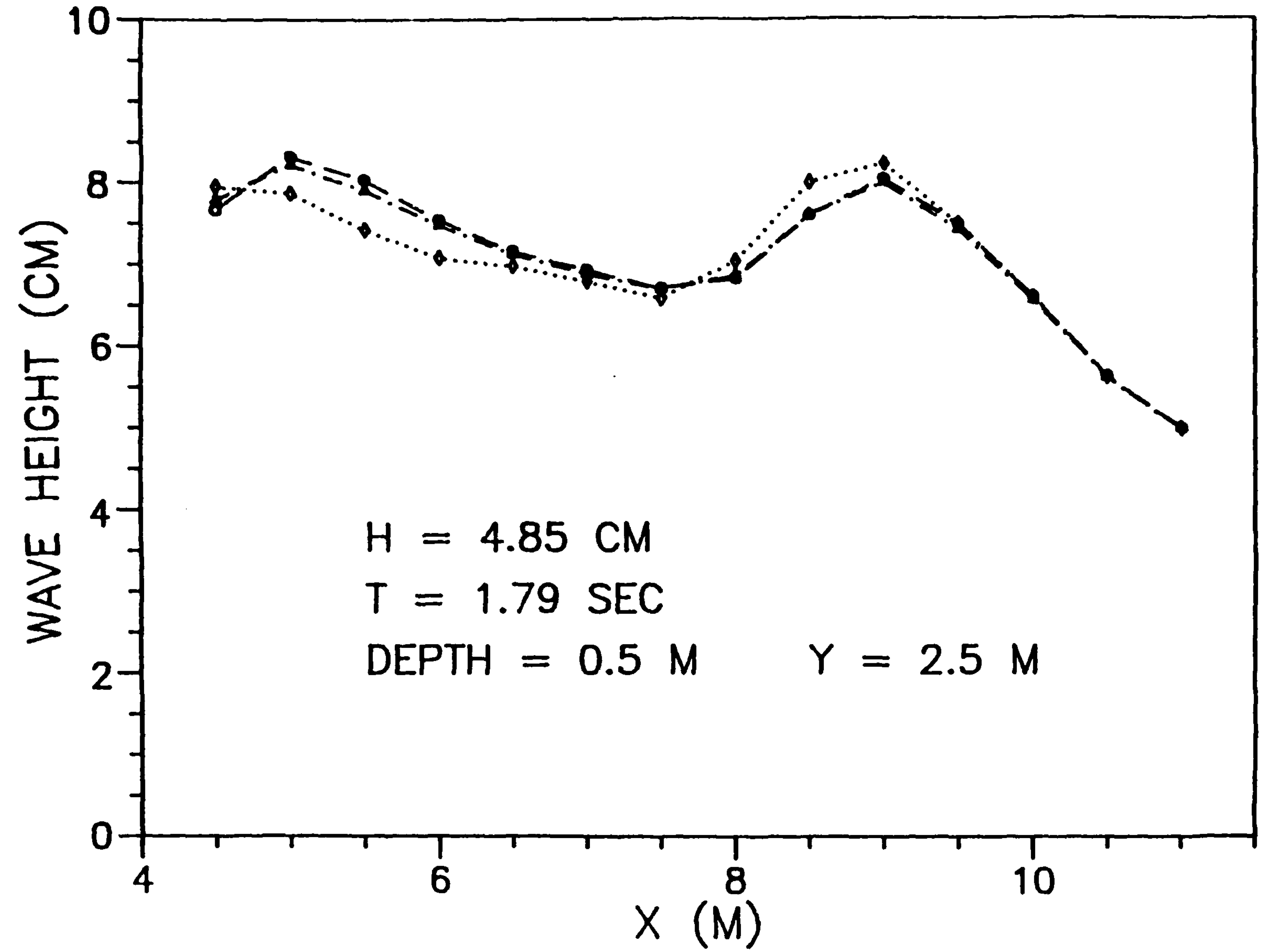


Figure 3.2i Comparison of Wave Heights between Numerical Results and Experimental Data; xxx and +++ experimental measurements; o-o-o, Δx=0.5 m, Δy=0.1m, Δ-·-Δ-·-Δ, Δx=0.5m, Δy=0.2m, Δx= Δy=0.5m.

the experimental data are also plotted. The over-all difference in wave amplitude using grid sizes equal to 0.2m and 0.1m are not significant. When the grid sizes are equal to 0.5m, numerical solutions change drastically. In this case, model accuracy depends more on the adequacy of the grid size to represent the topography rather than the wavelength. In Table 3.1 the computing times required on a VAX 11/750 to calculate the wave field from x = 15 m to 4m are shown for reference.

Numerical results agree with the experimental data in general. The two sets of experimental data shown represent measurements collected on both sides of the centerline. Discrepencies between the numerical solutions and experimental data could be caused by the non-uniformity of the wave amplitude across the wave tank. Note that the two sets of data should coincide, if the initial conditions were uniform.

For reference, sample input files of DEPTH. DAT, LOC. DAT are listed in Appendix A. The format of these files is explained in section 4.

3.2 Obliquely Incident Waves Propagating Over a Submerged Shoal on a Sloping Bottom

Berkhoff et al. (1982) conducted laboratory experiments to examine wave propagation over a submerged shoal on a sloping bottom. The slope of the bottom topography, s, is 0.02 and the outer edge of the shoal can be described by (Berkhoff et al. 1982; Dingemans 1985):

$$\left(\frac{x - x_c}{3}\right)^2 + \left(\frac{y - y_c}{4}\right)^2 = 1 \qquad (3.2)$$

where $(x_c, y_c) = (17.0156\text{m}, 0\text{m})$. The sloping beach blends into a region with constant depth, $h = 0.45\text{m}$, at a distance of 22.5m from the shore. The bathymetry is given as

$$h = sx, \text{ for } [(\frac{x - x_c}{3})^2 + (\frac{y - y_c}{4})^2] > 1 \text{ and } x \leq 22.5\text{m},$$

$$h = sx + 0.3 - 0.5 \sqrt{1 - (\frac{x - x_c}{5})^2 - (\frac{x - x_c}{3.75})^2} \quad ,$$

$$\text{for } (\frac{x - x_c}{3})^2 + (\frac{y - y_c}{4})^2 \leq 1$$

$$h = 0.45\text{m} \quad , \quad x \geq 22.5\text{m} \tag{3.3}$$

In the laboratory experiments the incident wave train had a period of 1.0 sec. with an angle of incidence, θ_0 equal to -20 degrees relative to x-axis in the constant depth region. Wave amplitudes were measured along eight cross-sections in terms of a rotated coordinate system (x', y') (See Figure 3.3):

$$x' = (x - x_c) \cos \theta_0 - (y - y_c) \sin \theta_0$$
$$y' = (x - x_c) \sin \theta_0 + (y - y_c) \cos \theta_0 \tag{3.4}$$

Numerical results are obtained from all three models using different coordinate systems. The accuracy and efficiency of these models are compared. To have meaningful comparisons, identical grid sizes are used for the three models. Different angles of incidence, $\theta_o = -10^0$, -20^0 and -30^0 are used in the computations. For the case where the incident angle is -20^0, the accuracy of three models are first verified by comparing with laboratory measurements. As shown in Figures 3.4, the wave field in the neighborhood of caustics is predicted reasonably well by the present models; both the location of maximum magnitude and the variation of wave amplitude agree reasonably with experimental data. There is almost no difference between results using curvilinear coordinates and those using the rotated Cartesian coordinates.

However, an appreciable difference of amplitude distribution is observed between results obtained using the fixed Cartesian coordinates model and the other two models. Difference becomes greater for larger angles of incidence (see Figures 3.5 for $\theta_o = -10^0$ and Figures 3.6 for $\theta_o = -30^0$). None of the three models accurately predicts the secondary peaks of amplitude distribution along cross sections defined by constant x' values. This is partly because any nonlinearity has been ignored in the present models. Much of the deviation between model results and measured data can be eliminated by including nonlinear effects. (Kirby and Dalrymple, 1984; Dingemans and Radder, 1986).

In Table 3.2, both the required CPU times (on VAX 11/750) and numbers of nodal points are summarized for $\Delta\sigma = \Delta\rho = 0.25$m. Due to the effects of the scaling factors used in the coordinate transformations, the number of grid points required in the curvilinear coordinates model increases very quickly as the incident angle approaches normal incidence (the curvilinear coordinate transformation becomes invalid for normal incidence). Consequently, the CPU time increases significantly. Both Cartesian coordinate formulations involve scaling factors of 1; therefore, the number of nodal points and CPU time do not change for different incident angles. For a particular angle of wave incidence, comparisons of CPU times show that most of computational effort arises from calculations associated with the coordinate transformation. Prior to computing the wave field, water depths along several cross-sections are digitized and stored in a file of DEPTH.DAT with the corresponding coordinates in file of LOC.DAT (See Appendix B).

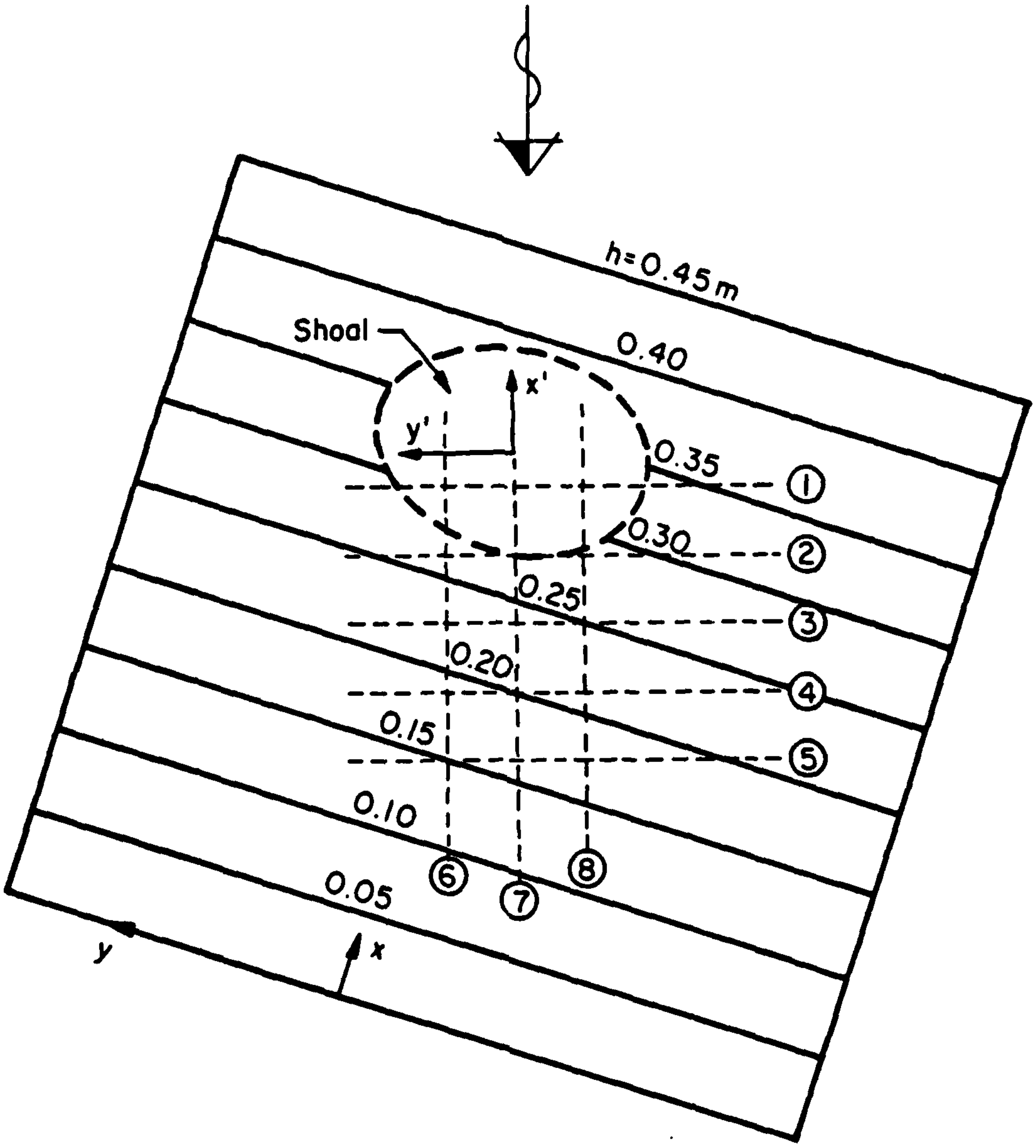


Figure 3.3 Sketch of the Geometry of a Submerged Shoal on a Sloping Beach

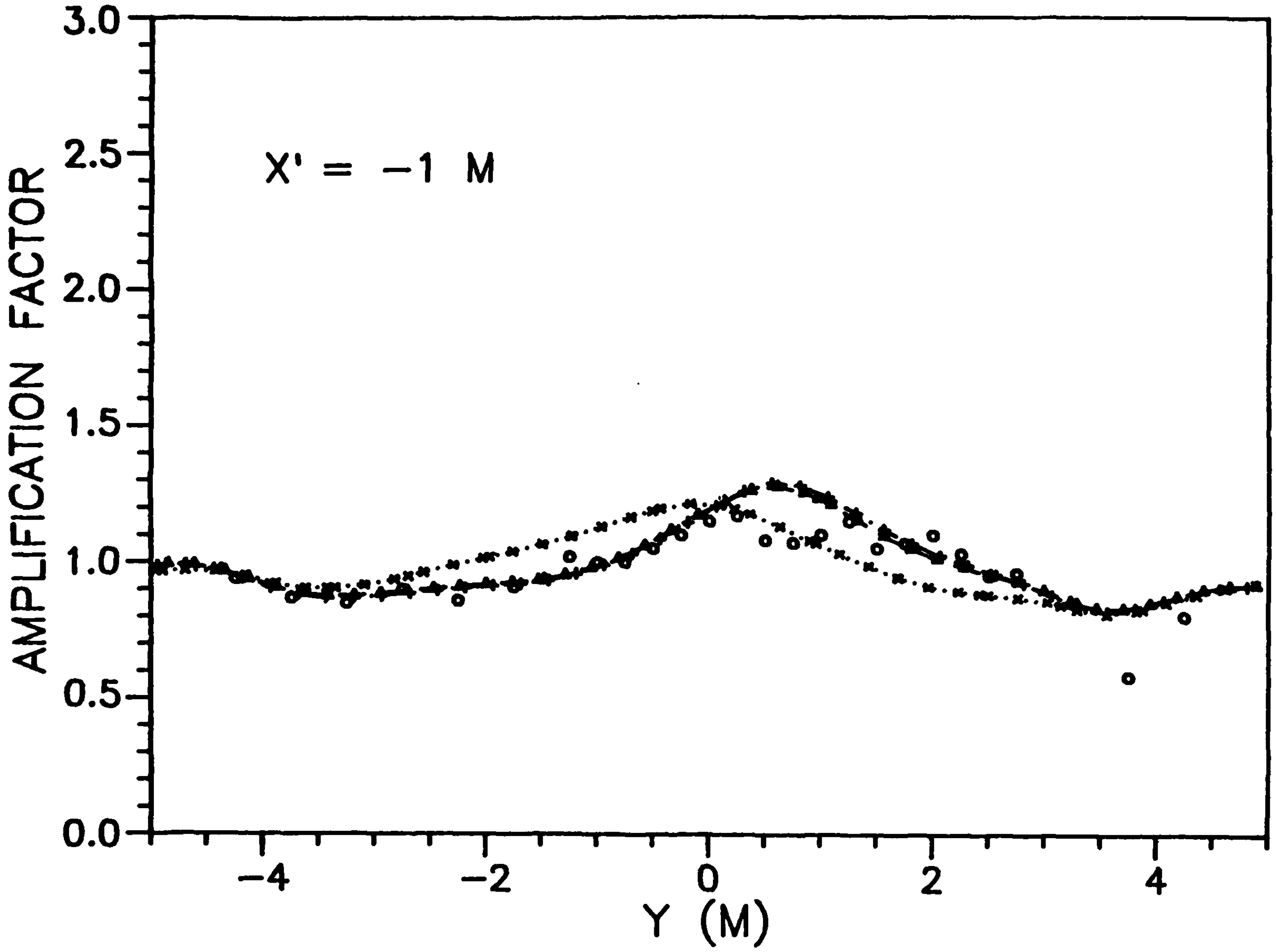


Figure 3.4a Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, Θ=-20°; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

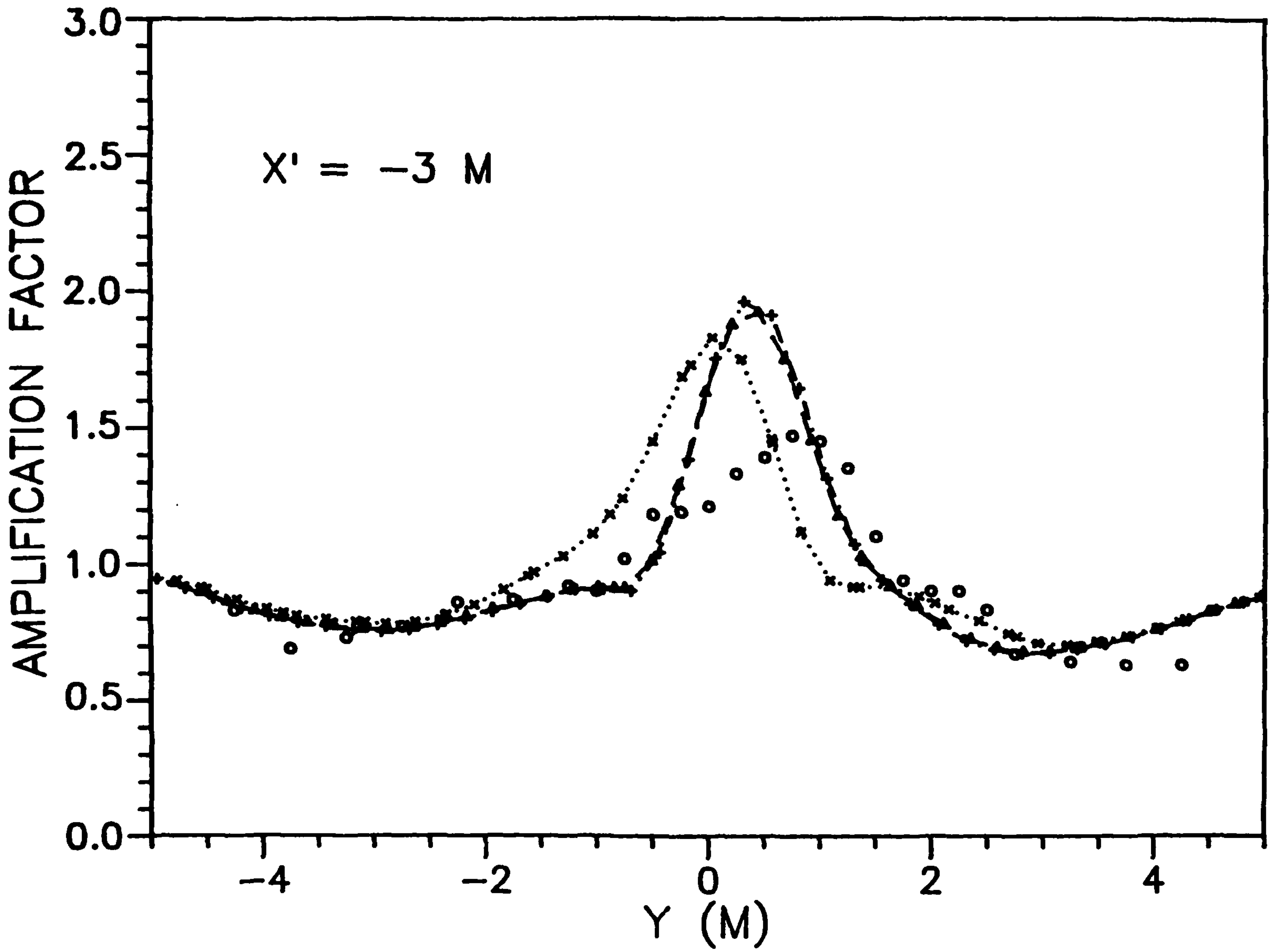


Figure 3.4b Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, Θ=-20°; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

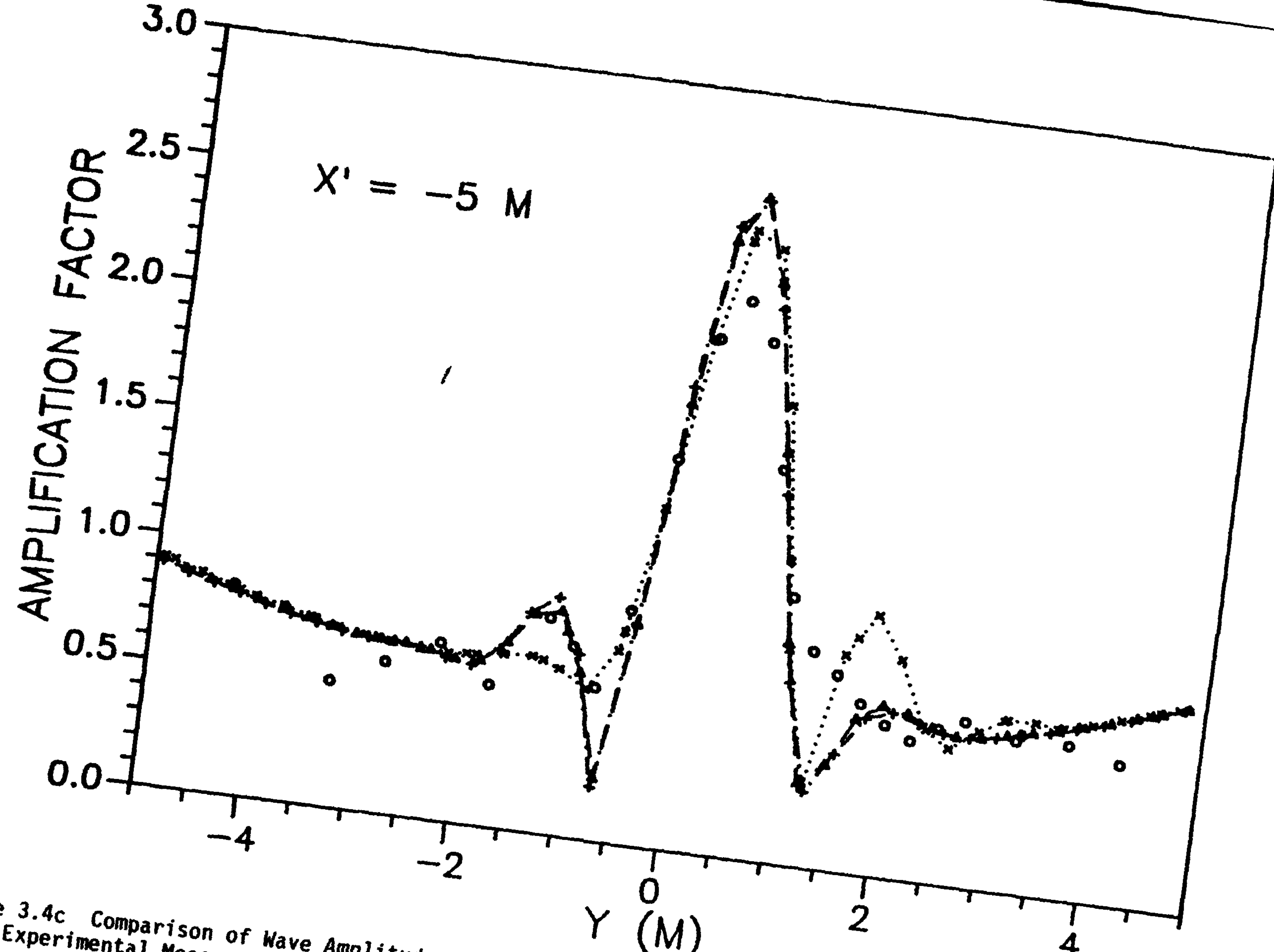


Figure 3.4c Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, $\theta=-20°$; o o o Experimental Measurements; Δ-Δ-Δ , Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

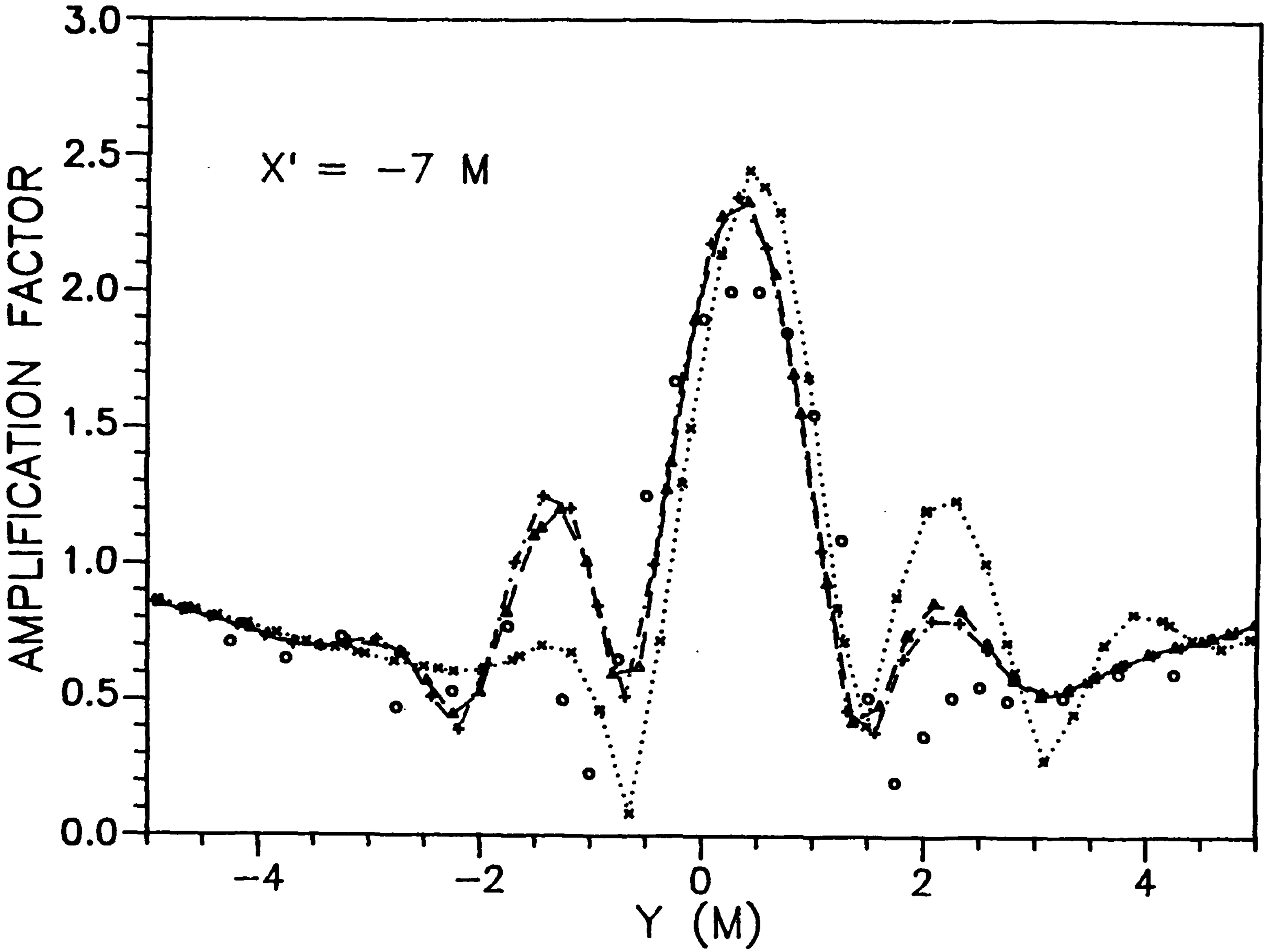


Figure 3.4d Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, 0=-20°; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

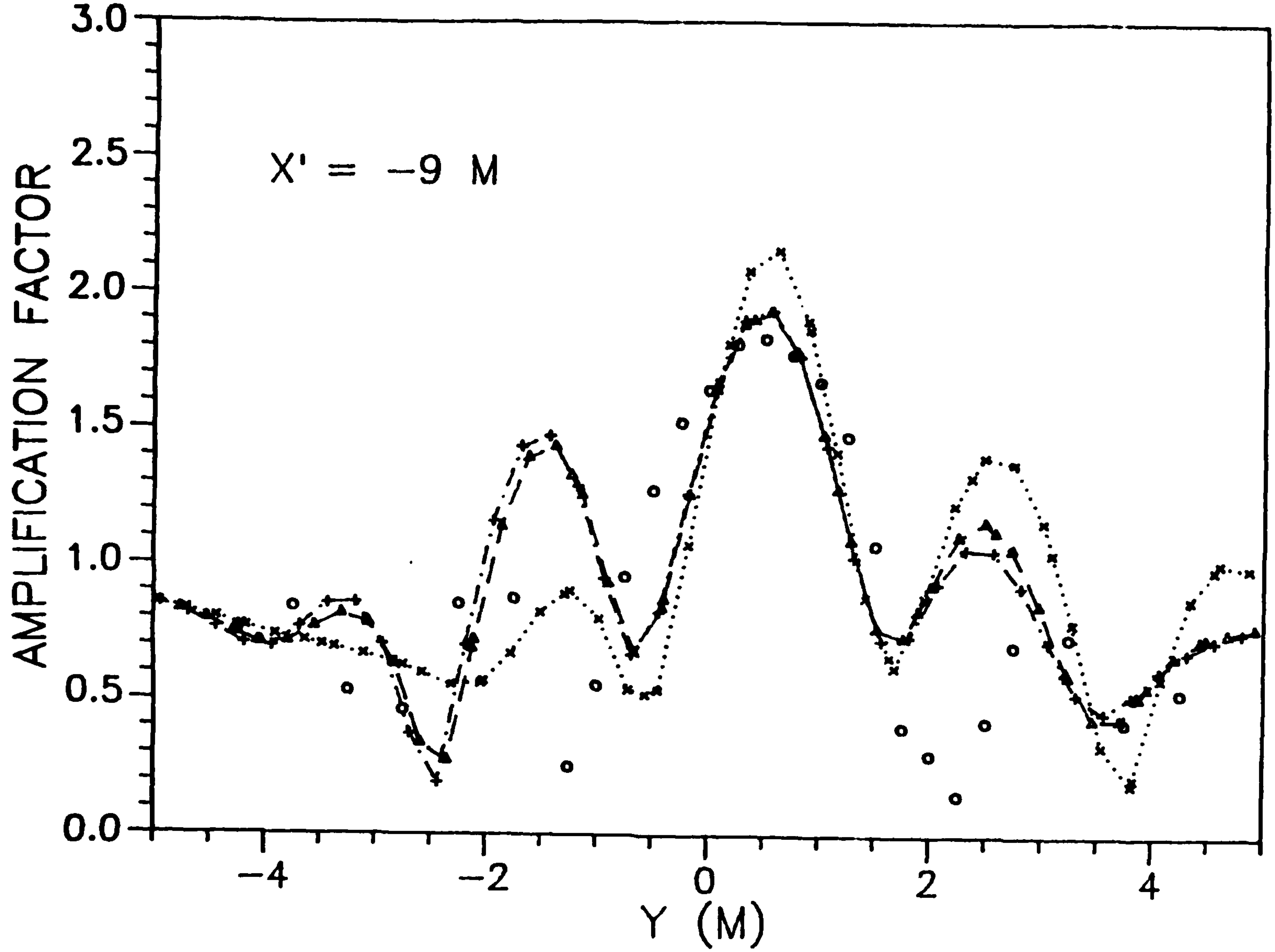


Figure 3.4e Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, $\theta=-20^{\circ}$; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

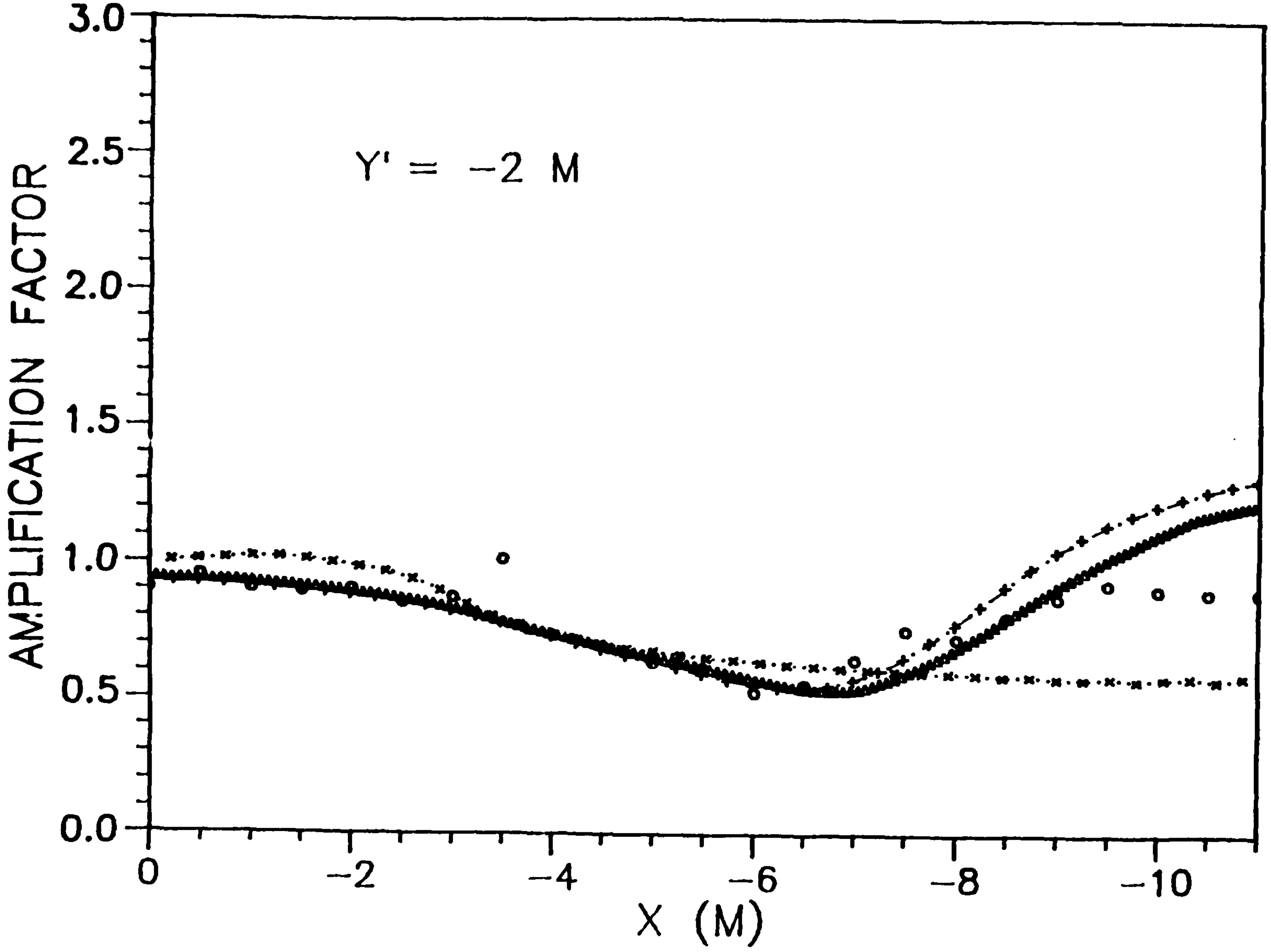


Figure 3.4f Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, $\theta=-20^{o}$; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

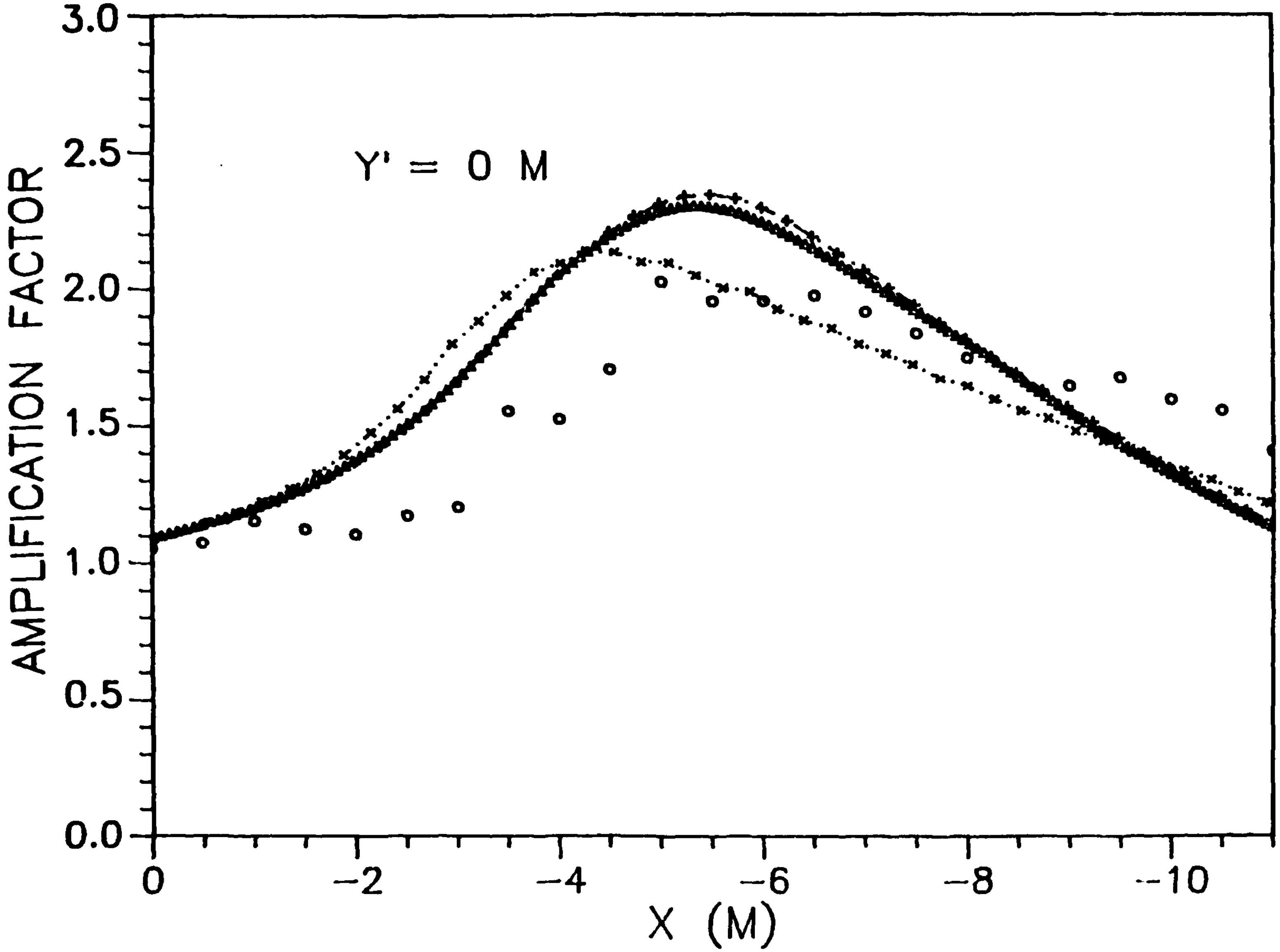


Figure 3.4g Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, $\Theta=-20^{o}$; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +---+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

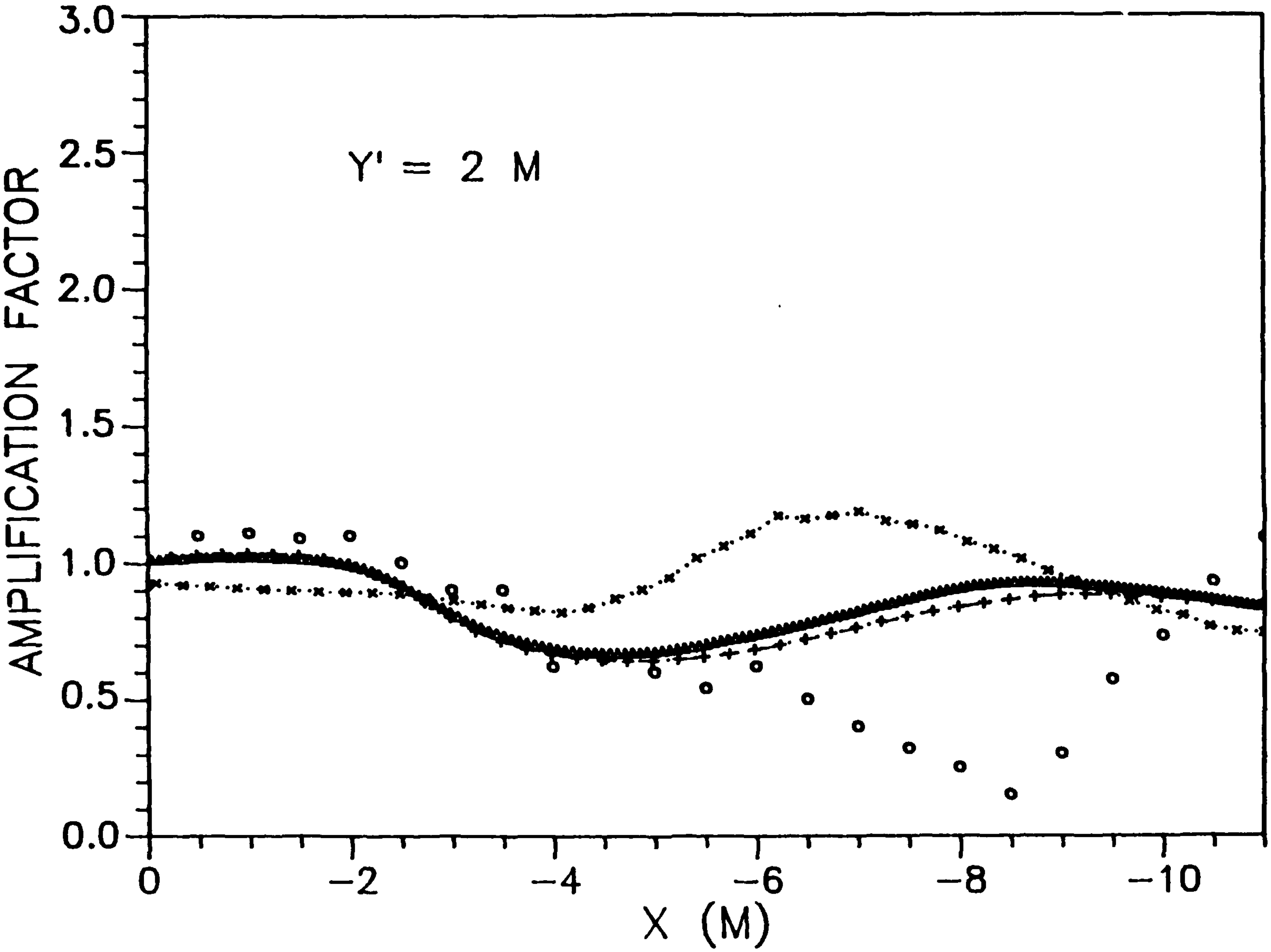


Figure 3.4h Comparison of Wave Amplitudes between Numerical Results and Laboratory Data, $\theta=-20^{\circ}$; o o o Experimental Measurements; Δ-Δ-Δ, Curvilinear Coordinates; +-·-+, Rotated Cartesian Coordinates and x·x·x , Fixed Cartesian Coordinates.

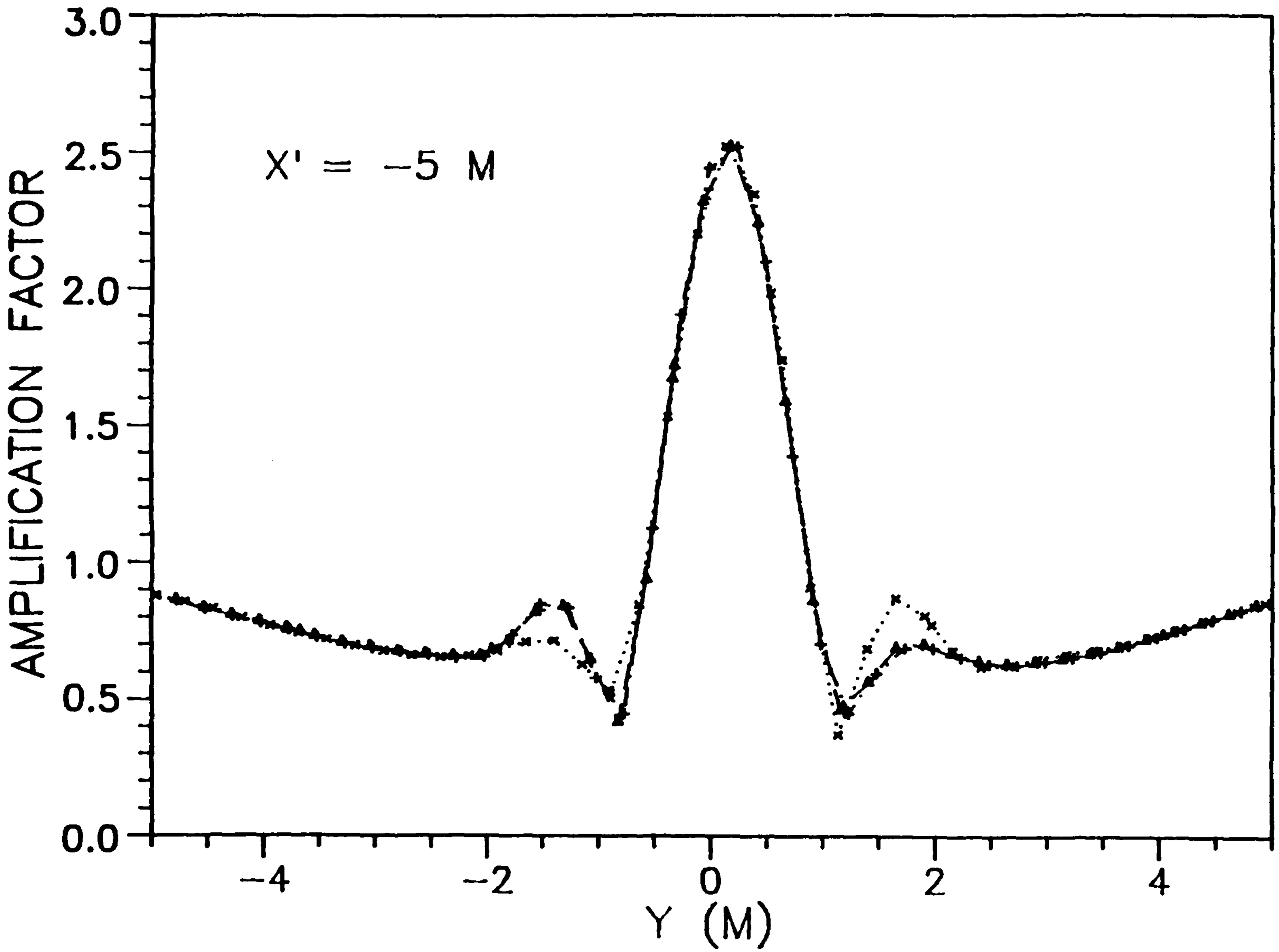


Figure 3.5a Comparison of Normalized Wave Amplitude between Numrical Results, =-10°, Δ-Δ-Δ: Curvilinear Coordinates, +-··-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

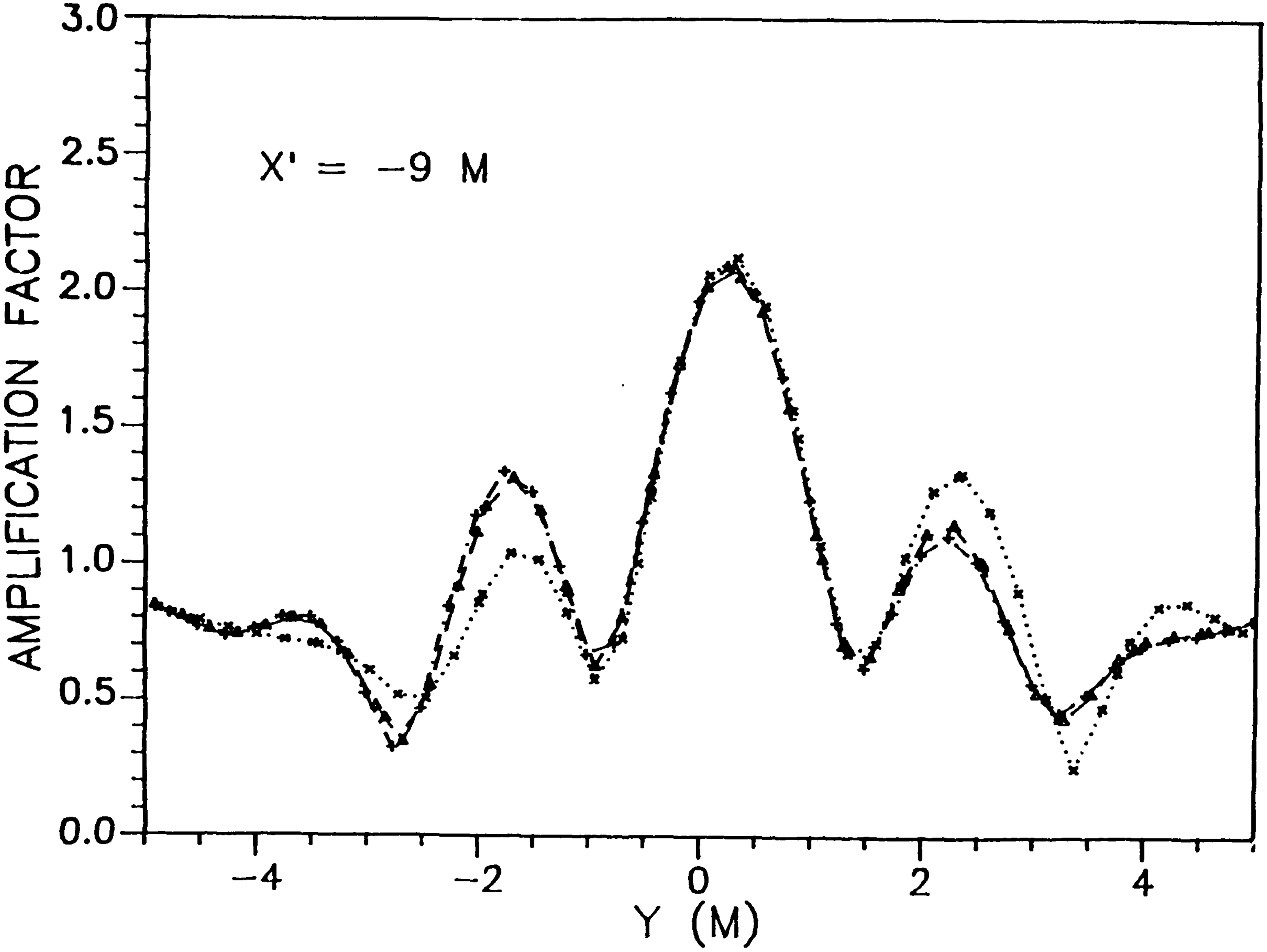


Figure 3.5b Comparison of Normalized Wave Amplitude between Numrical Results, =-10°, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

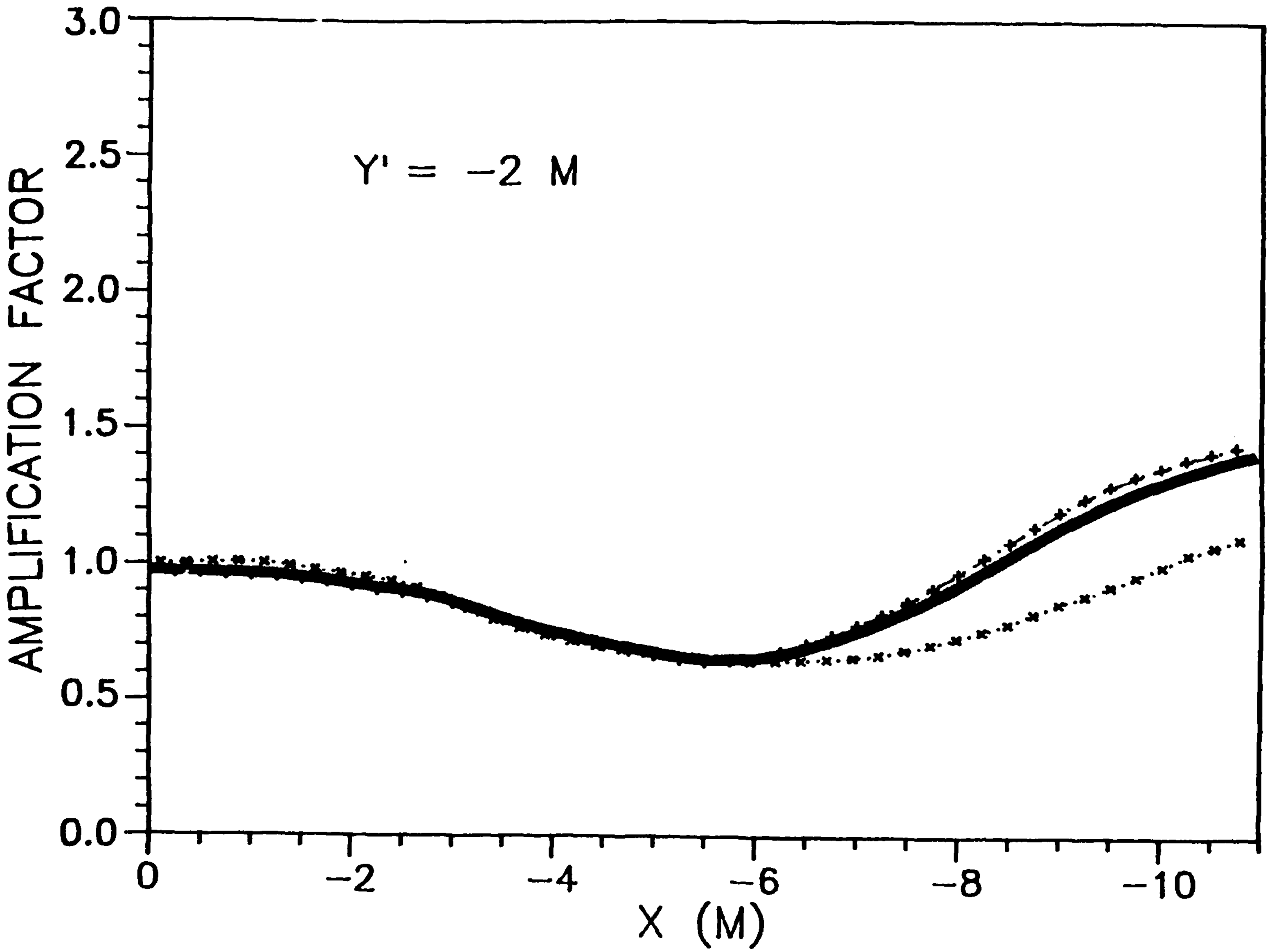


Figure 3.5c Comparison of Normalized Wave Amplitude between Numrical Results, =-10°, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

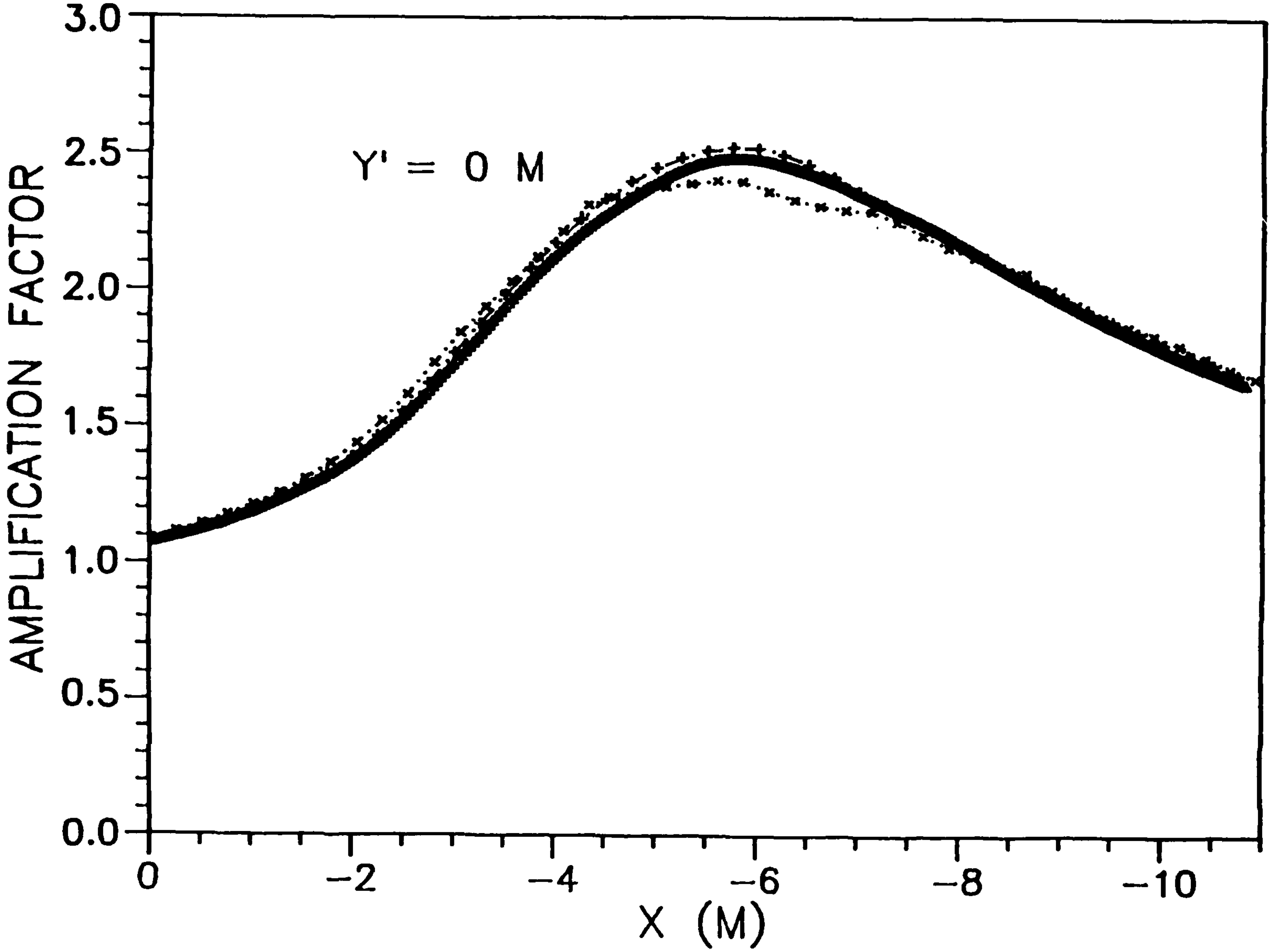


Figure 3.5d Comparison of Normalized Wave Amplitude between Numrical Results, =-10^{o}, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

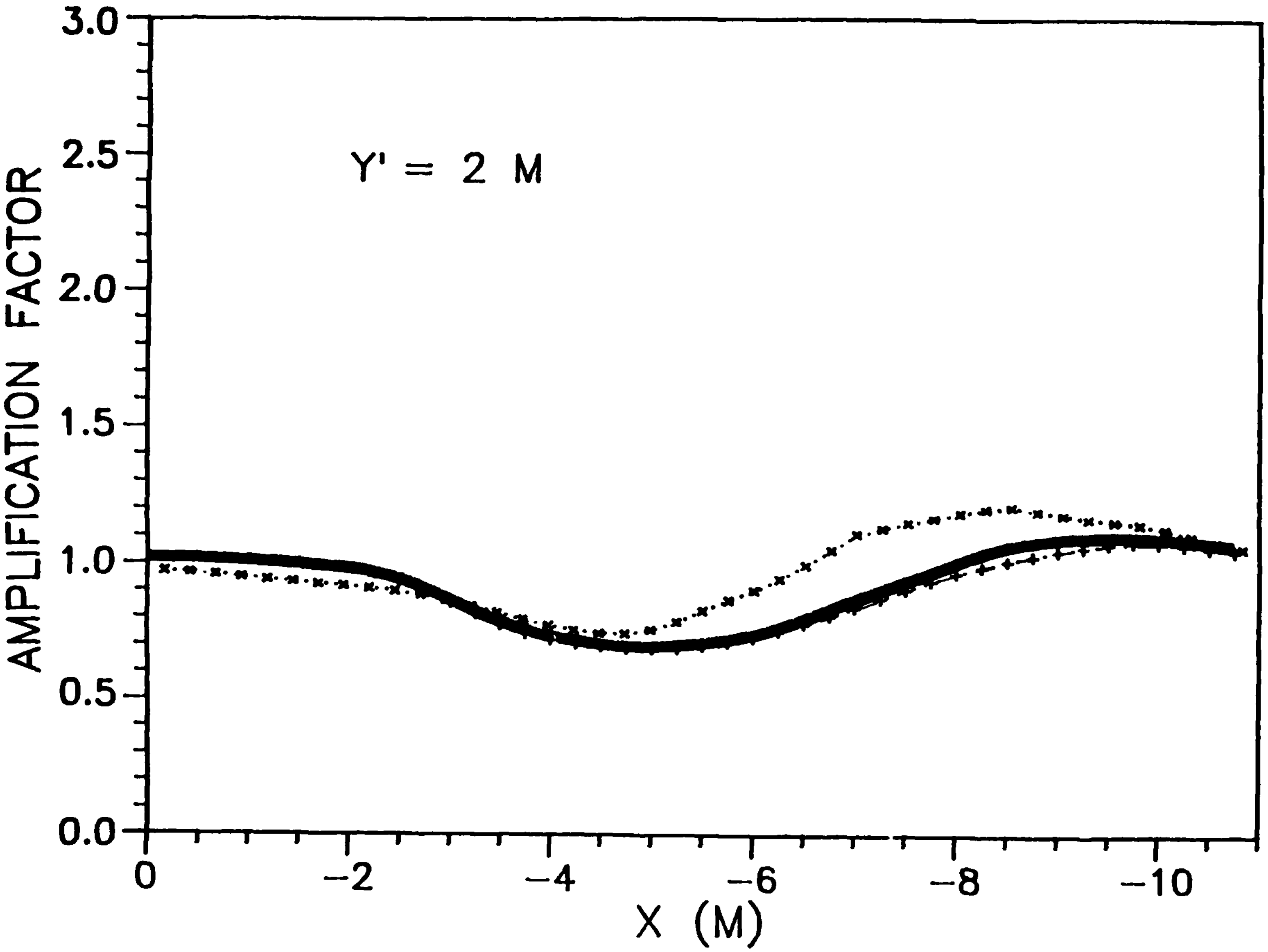


Figure 3.5e Comparison of Normalized Wave Amplitude between Numrical Results, =-10°, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

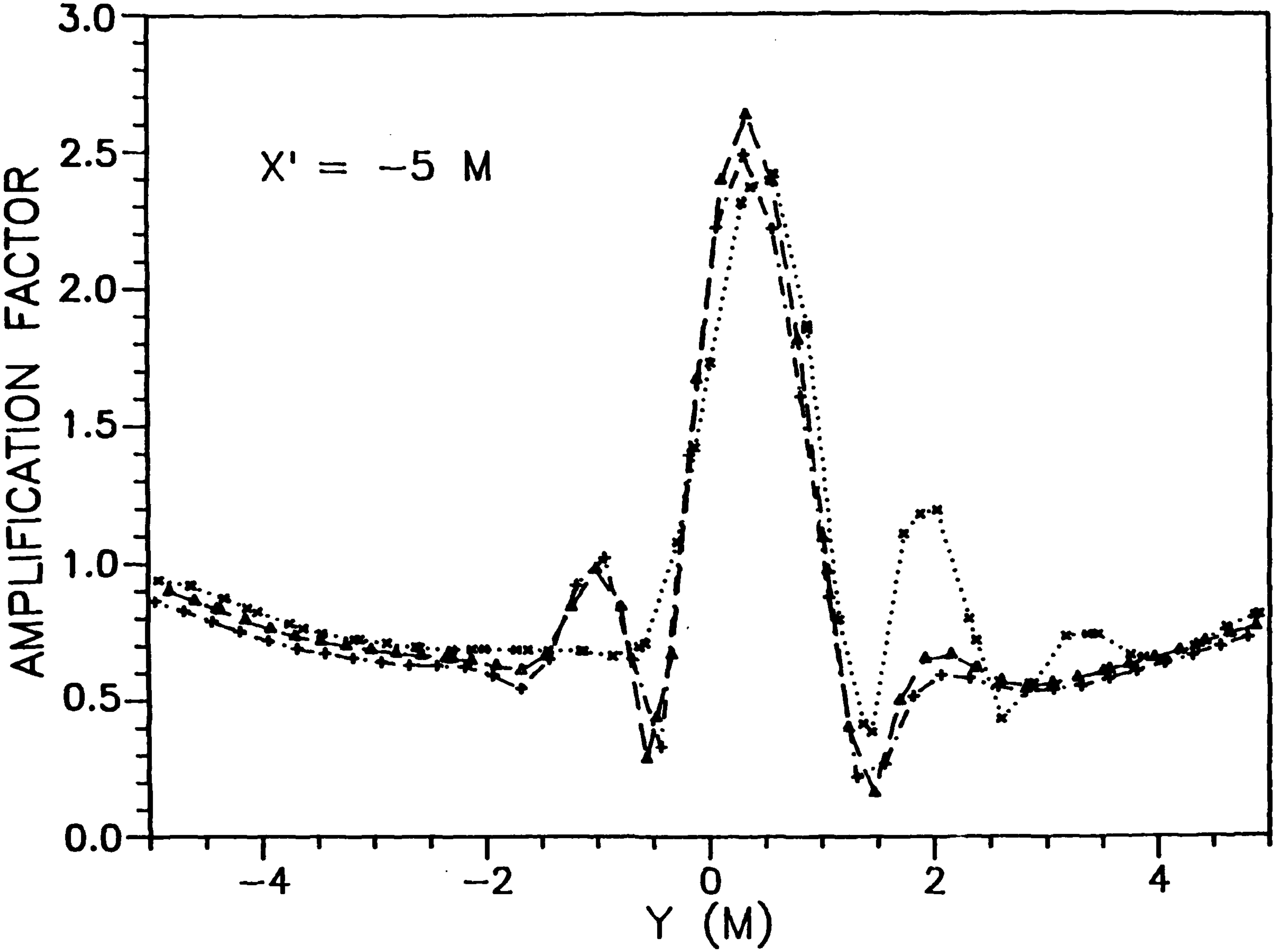


Figure 3.6a Comparison of Normalized Wave Amplitude between Numerical Results, $\theta = -30^{o}$, Δ-Δ-Δ: Curvilinear Coordinates, +---+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

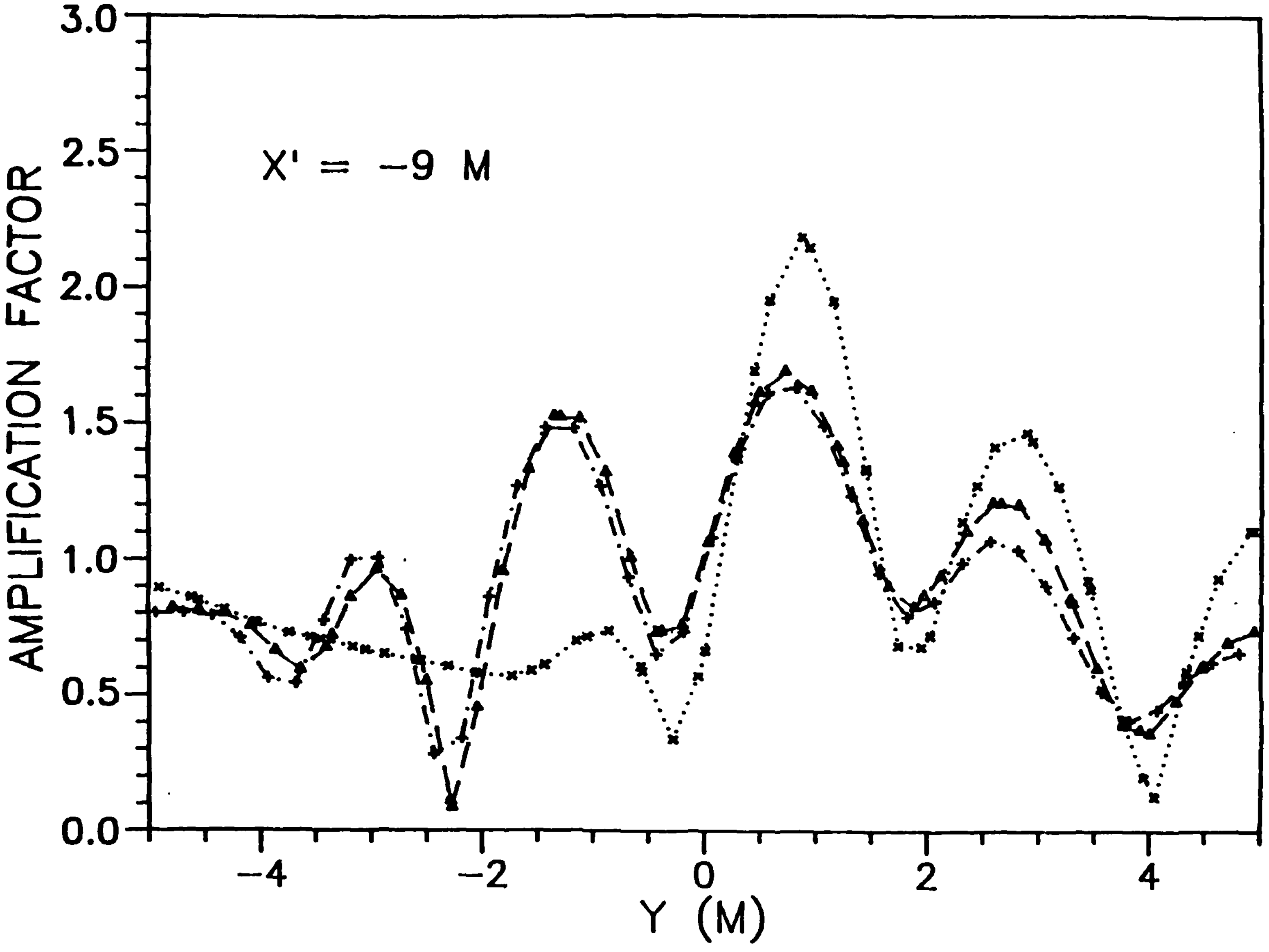


Figure 3.6b Comparison of Normalized Wave Amplitude between Numerical Results, $\theta = -30^{\circ}$, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

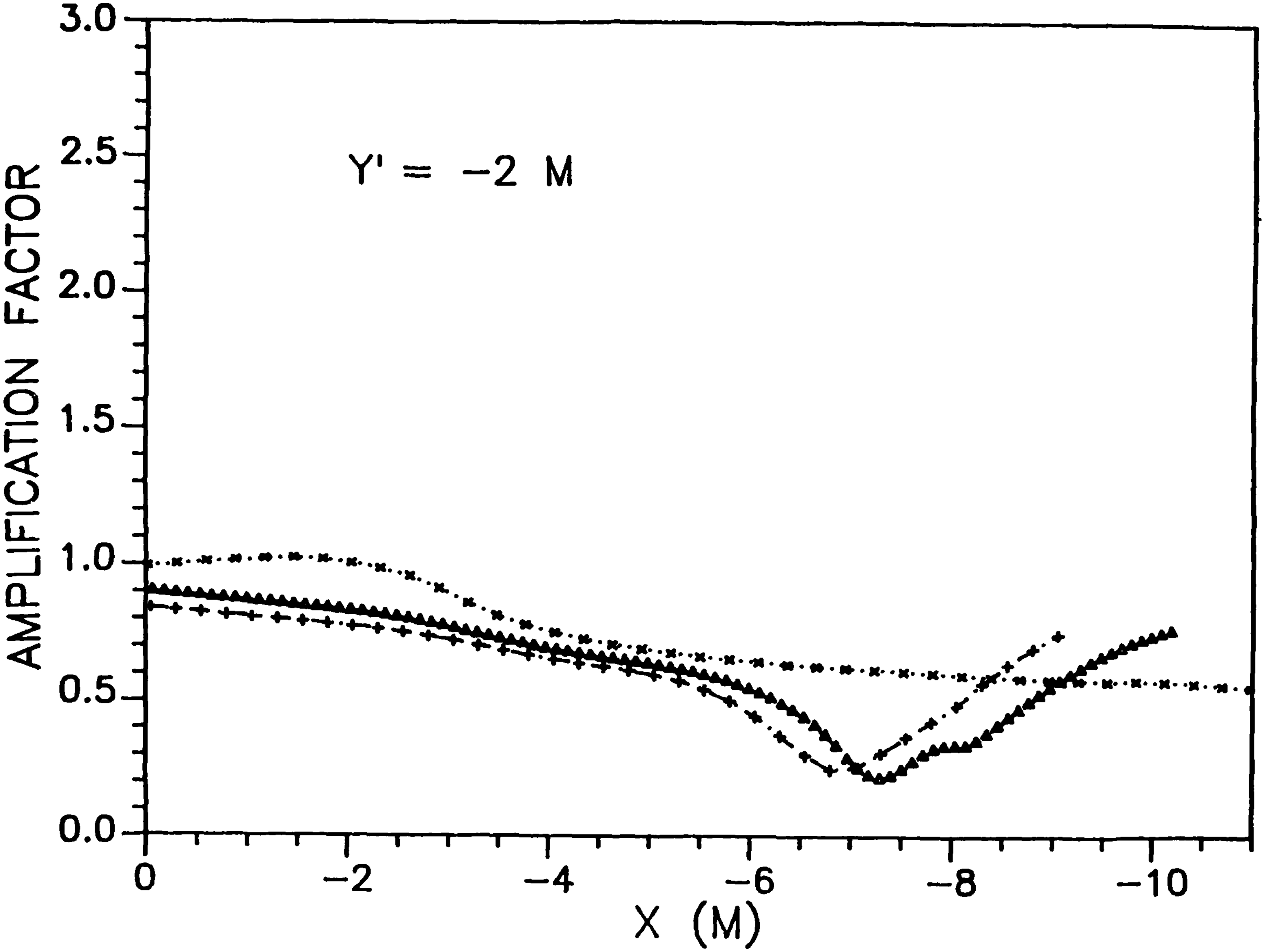


Figure 3.6c Comparison of Normalized Wave Amplitude between Numerical Results, $\theta = -30^{\circ}$, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

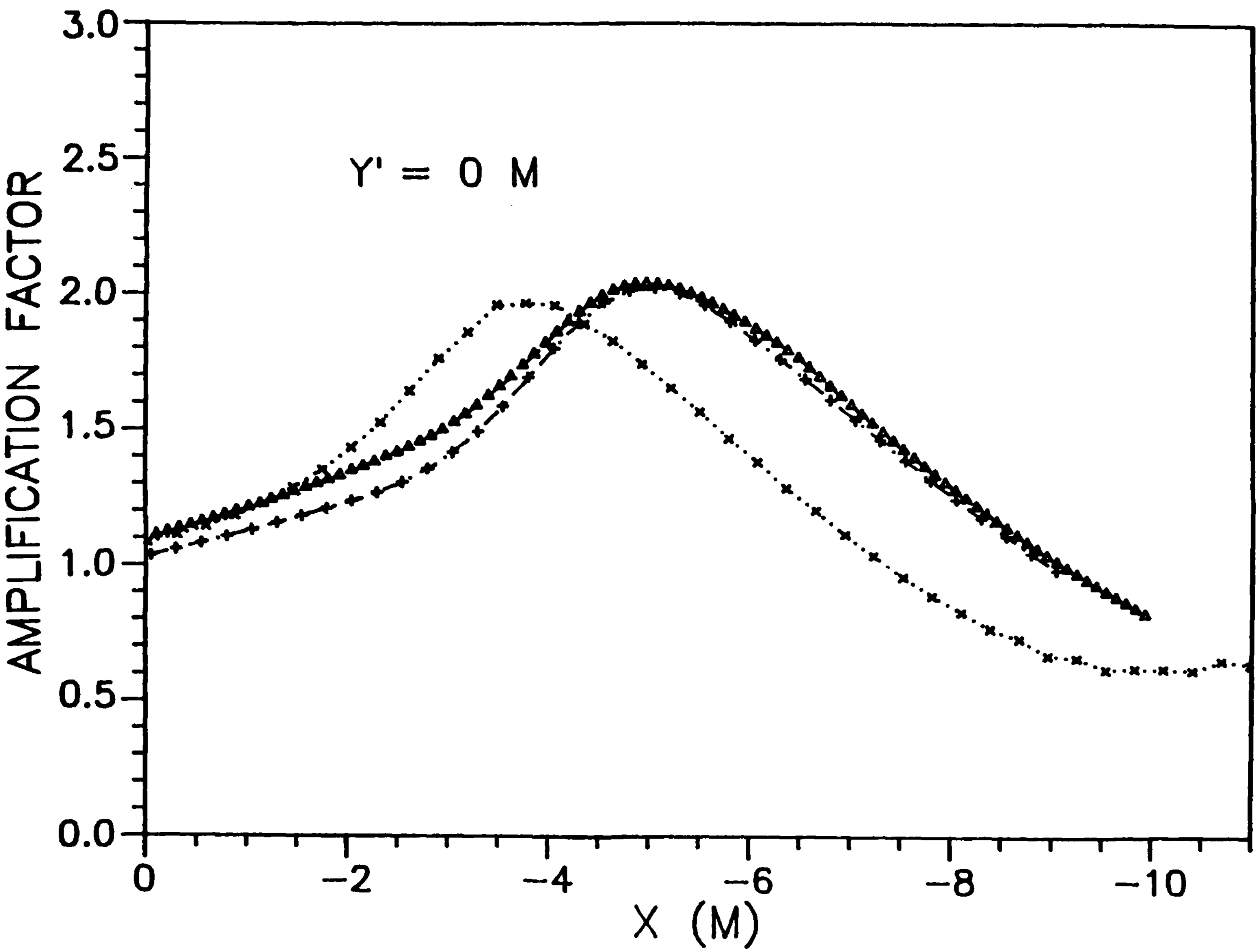


Figure 3.6d Comparison of Normalized Wave Amplitude between Numerical Results, $\theta = -30^{o}$, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

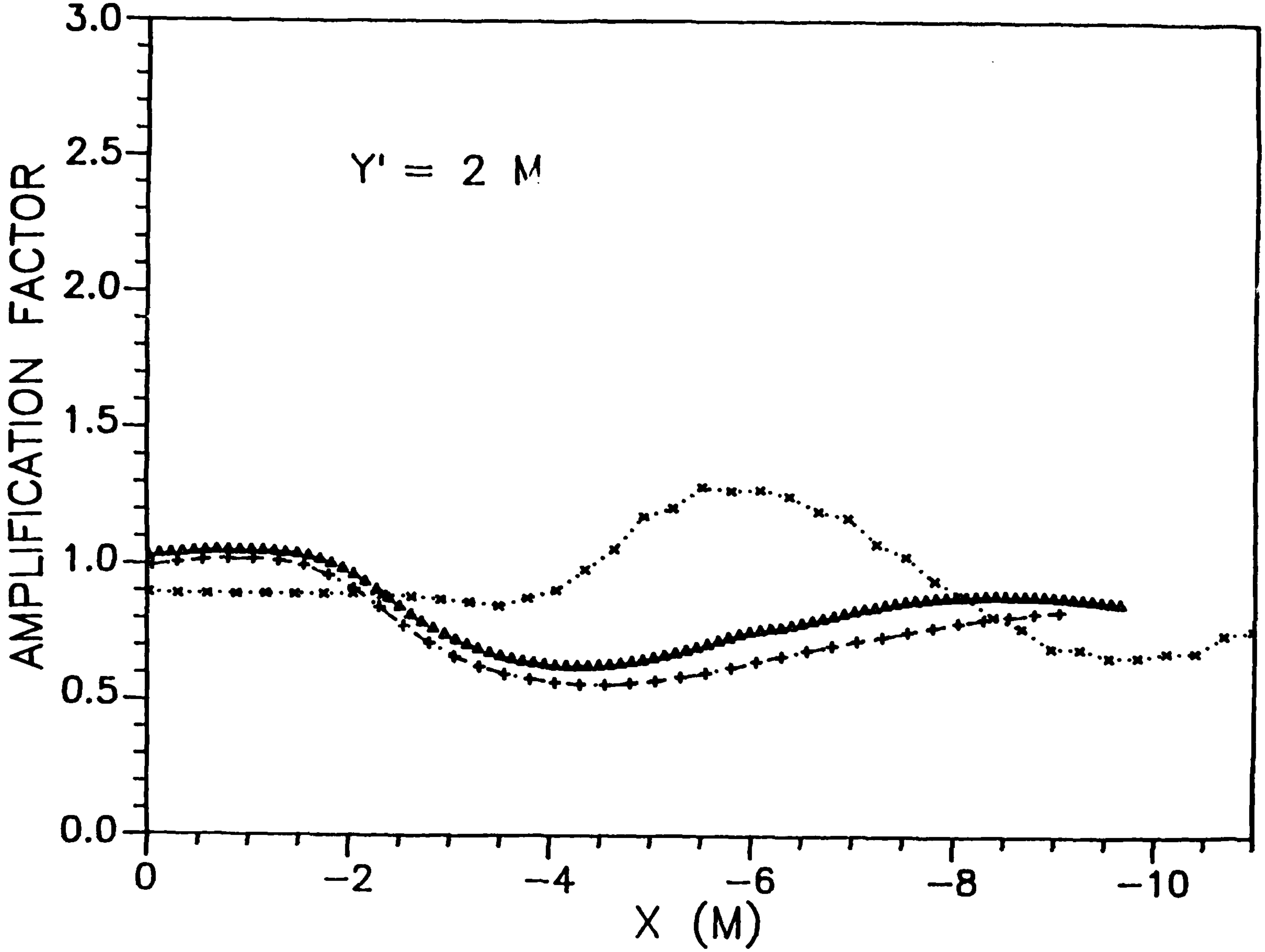


Figure 3.6e Comparison of Normalized Wave Amplitude between Numerical Results, $\theta = -30^{o}$, Δ-Δ-Δ: Curvilinear Coordinates, +-·-+: Rotated Cartesian Coordinates, and x·x·x: Fixed Cartesian Coordinates.

	Model 1 Curvilinear Coordinate	Model 2 Fixed Cartesian Coordinate	Model 3 Rotated Cartesian Coordinate
$\theta = -10^0$	M = 600, N = 200 CPU = 0.30 hr.	M = 80, N = 200 CPU = 0.05 hr.	M = 80, N = 200 CPU = 0.03 hr.
$\theta = -20^0$	M = 300, N = 200 CPU = 0.20 hr.	M = 90, N = 200 CPU = 0.05 hr.	M = 80, N = 200 CPU = 0.03 hr.
$\theta = -30^0$	M = 220, N = 200 CPU = 0.13 hr.	M = 95, N = 200 CPU = 0.07 hr.	M = 80, N = 200 CPU = 0.04 hr.

Table 3.2. CPU time and number of nodal points for different incident waves in three models

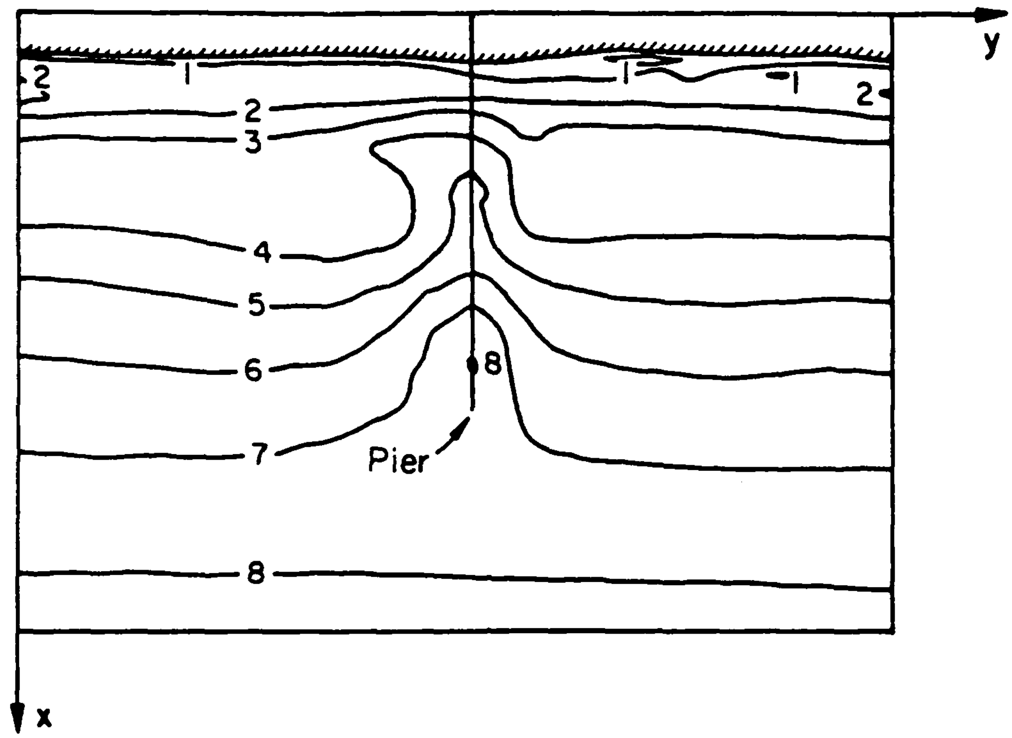
3.3 Waves over Varying Topography: A Field Case

The three models are applied to simluate prototype wave conditions observed in the vicinity of the Coastal Engineering Research Center Field Research Facility at Duck, North Carolina. Numerical results are compared for measurements with several different wave conditions, as shown in Table 3.3.

Case	Date	Time (GMT)	Ho (m)	T(sec)	θ_0 (deg)	Tide (m)	Date of Bathymetry Measurement
1	10-13-82	1300	1.95	13.21	23	0.12	10-16-82
2	10-13-82	1400	1.87	14.22	25	-0.18	10-16-82
3	10-15-82	1210	0.78	12.34	25	0.78	10-16-82
4	10-17-82	1200	1.56	6.87	-43	0.91	10-16-82
5	10-25-82	1900	3.10	12.34	25	0.68	10-27-82
6	10-25-82	2000	2.95	12.34	25	0.63	10-27-82

Table 3.3. Wave conditions of CERC field experiment

Figure 3.7 Bathymetry Contours near CERC Field Research Facility October 16, 1982



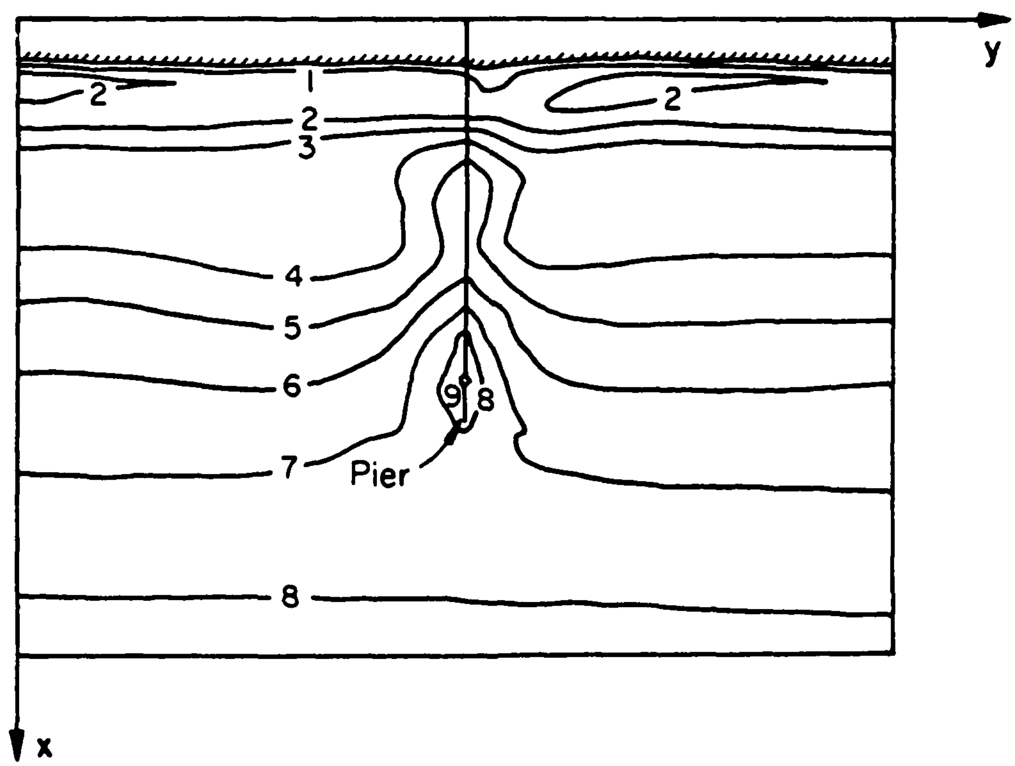


Figure 3.8 Bathymetry Contours near CERC Field REsearch Facility October 27, 1982

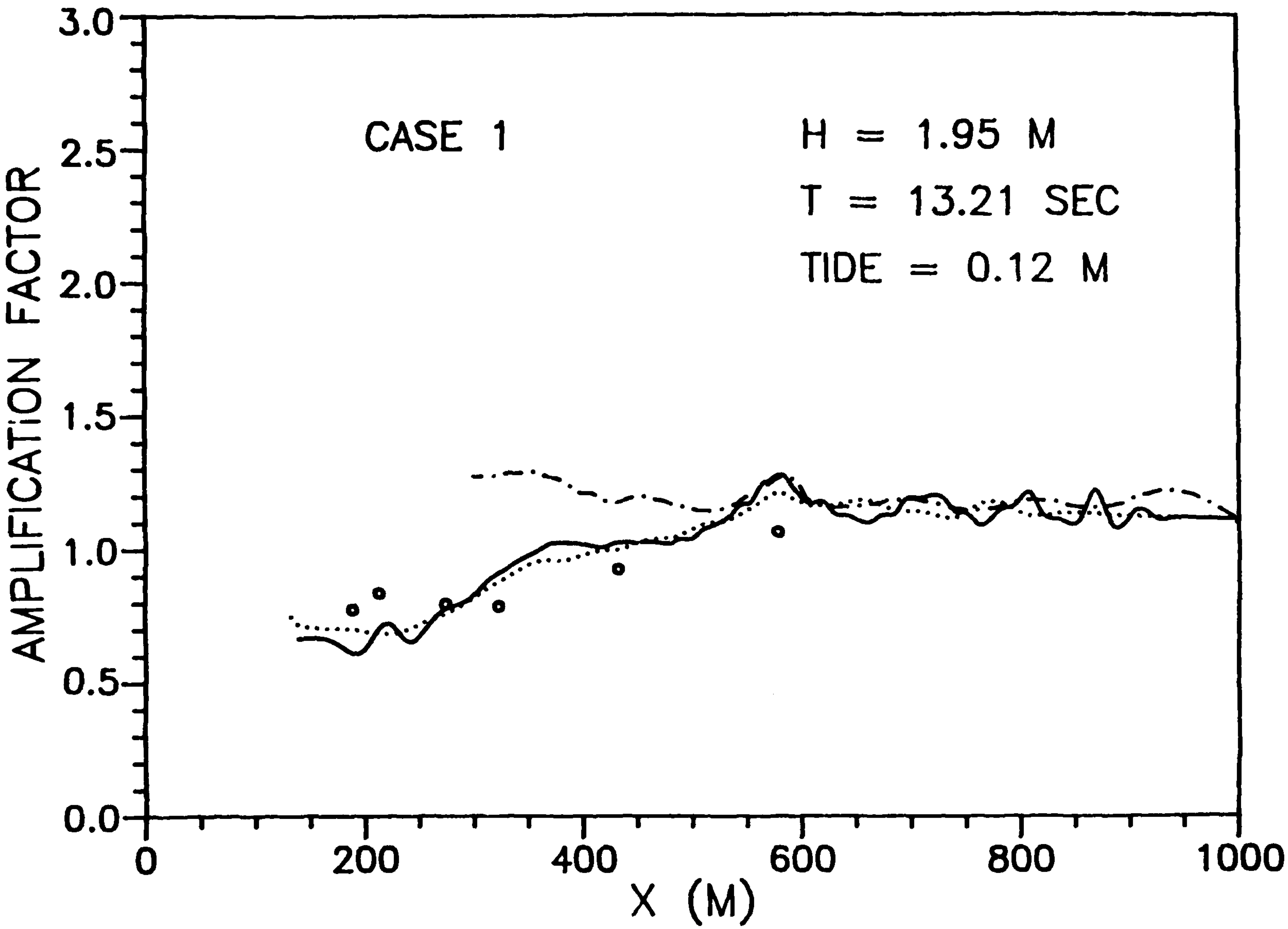


Figure 3.9a Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ... Rotated Cartesian Coordinates, —·— Fixed Cartesian Coordinates.

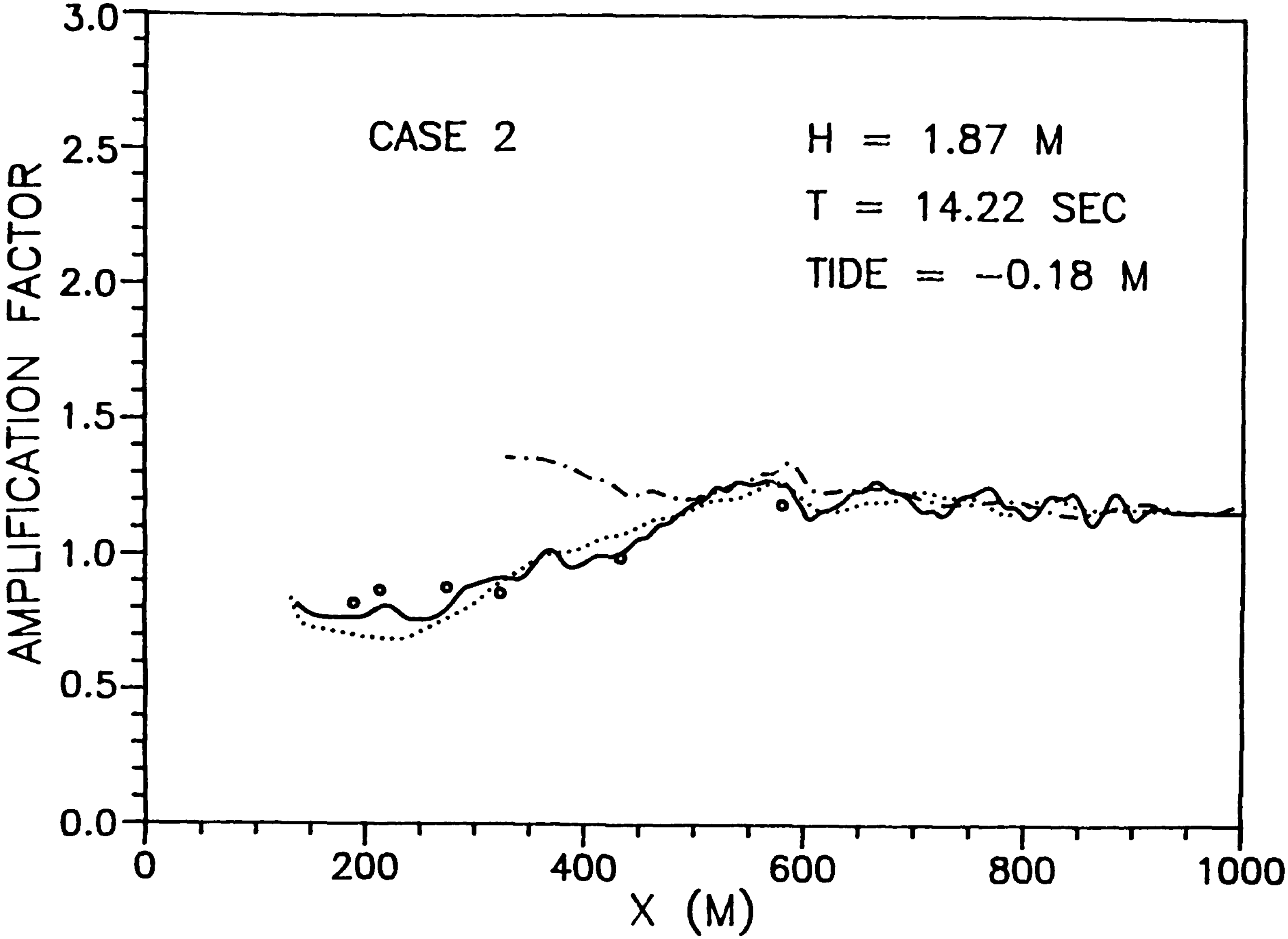


Figure 3.9b Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ·········Rotated Cartesian Coordinates, —·— Fixed Cartesian Coordinates.

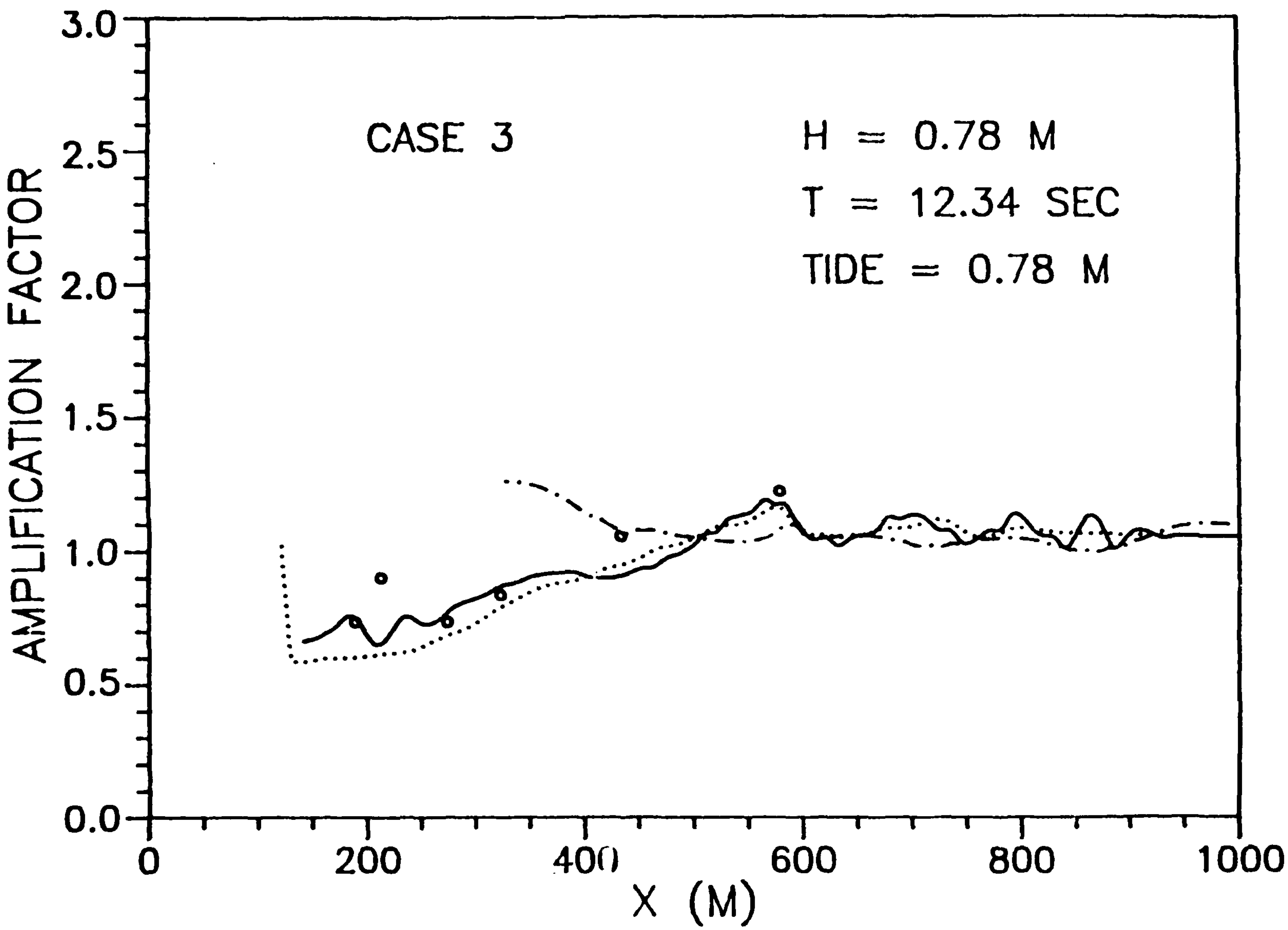


Figure 3.9c Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ········Rotated Cartesian Coordinates, —·— Fixed Cartesian Coordinates.

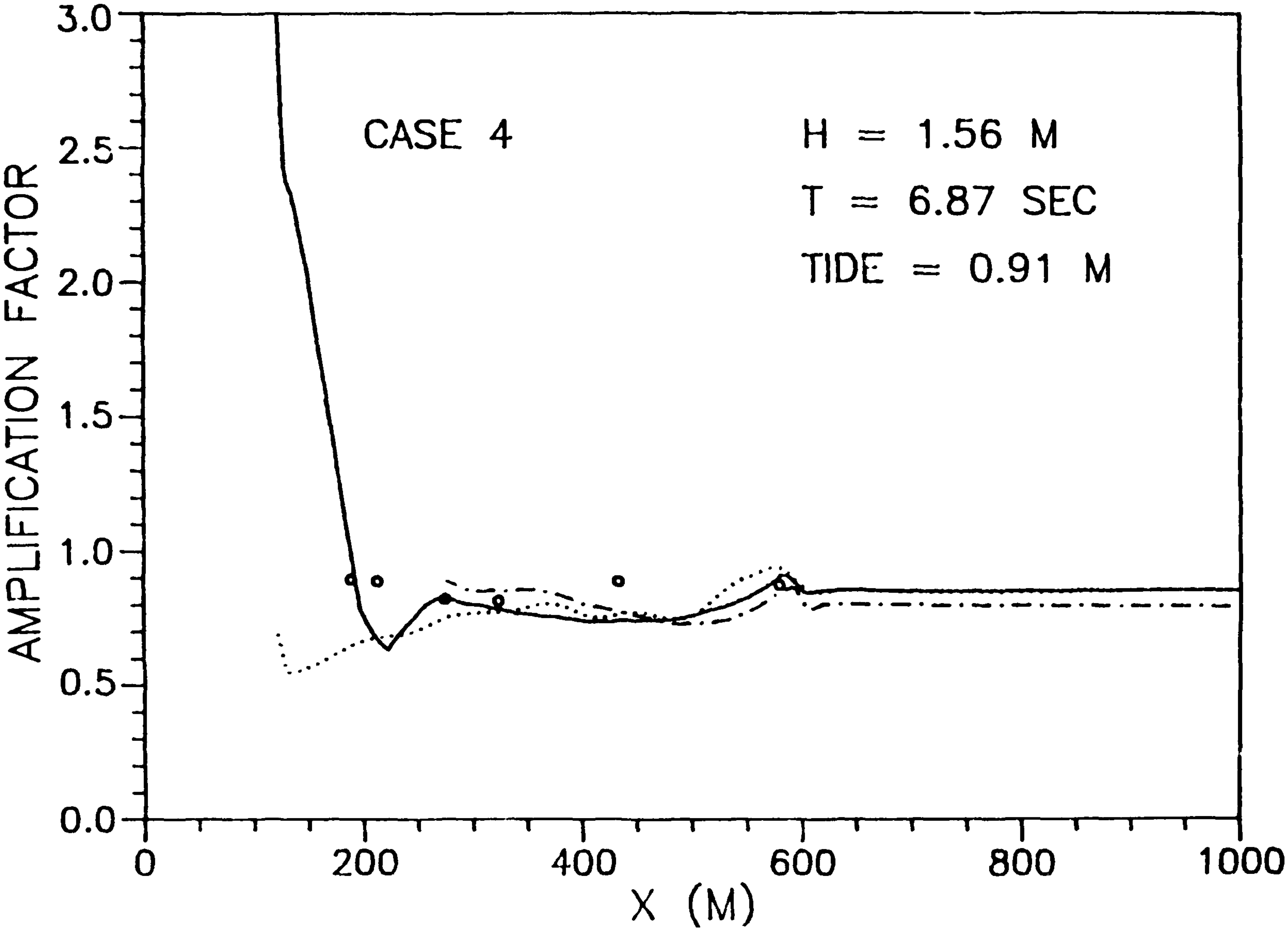


Figure 3.9d Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ········Rotated Cartesian Coordinates, —·—Fixed Cartesian Coordinates.

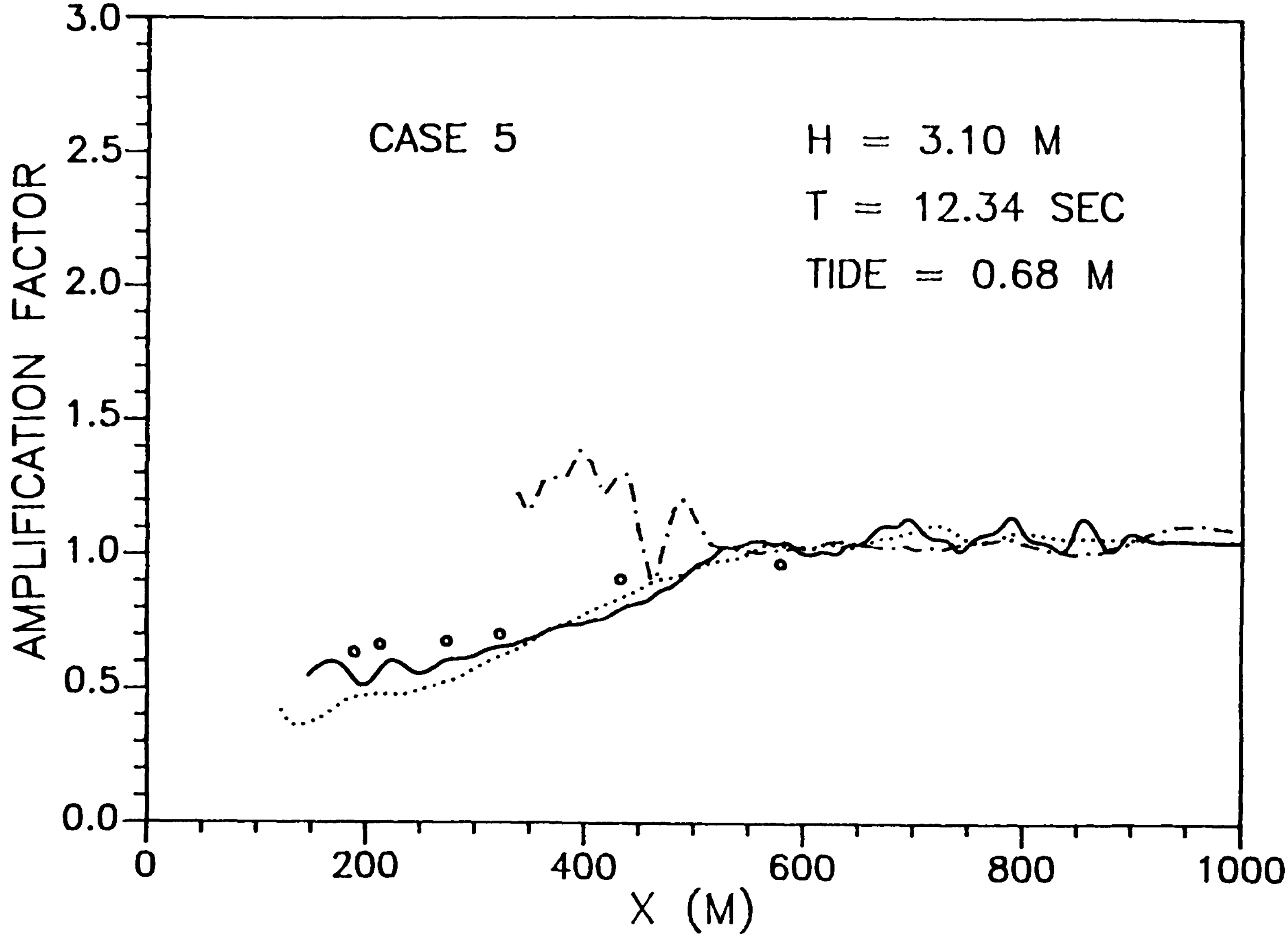


Figure 3.9e Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ········Rotated Cartesian Coordinates, —·—Fixed Cartesian Coordinates.

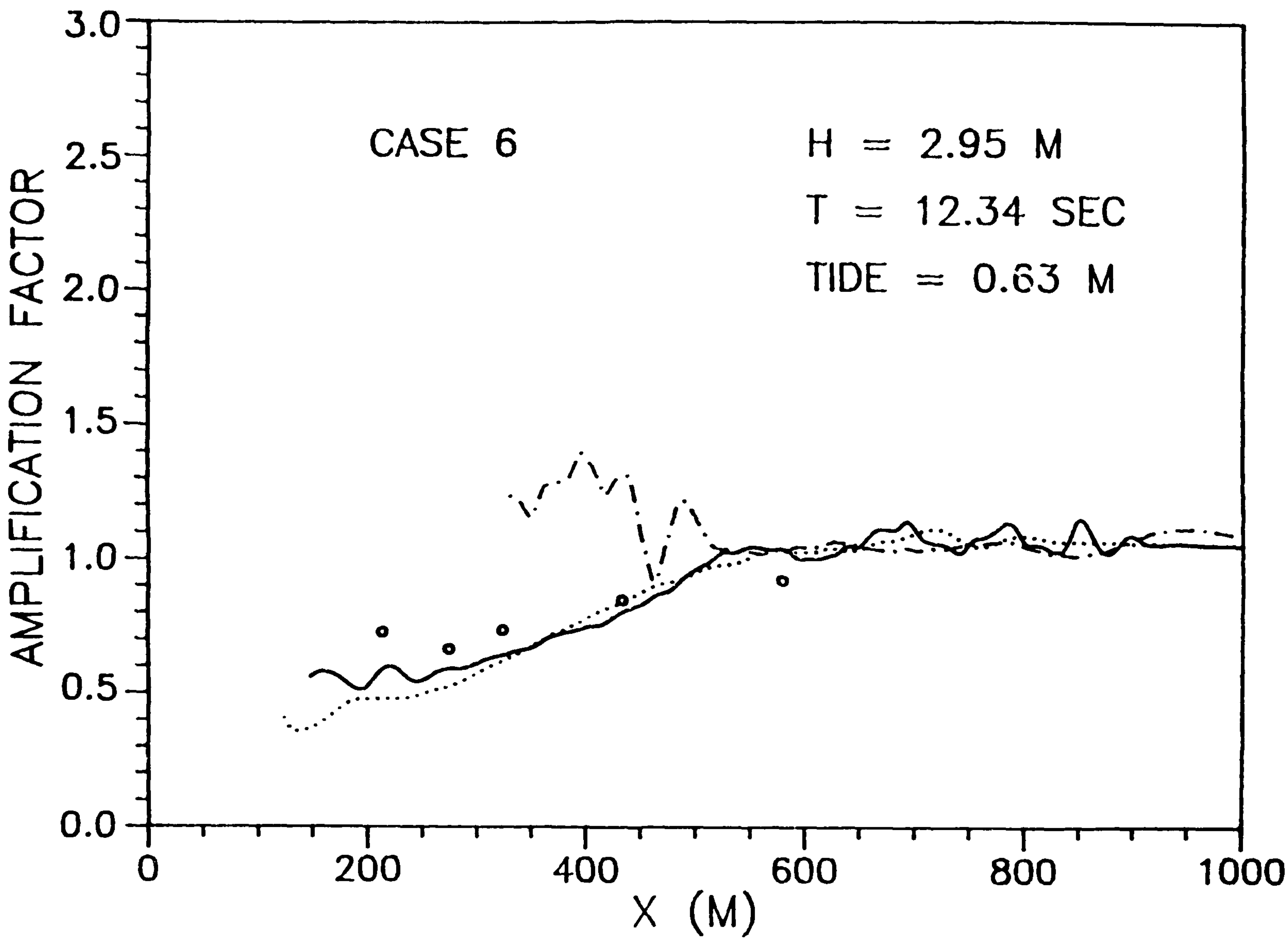


Figure 3.9f Comparison of Numerical Results of Three Models with Field Measurements; ooo field data, ——Curvilinear Coordinates, ········ Rotated Cartesian Coordinates, —·—Fixed Cartesian Coordinates.

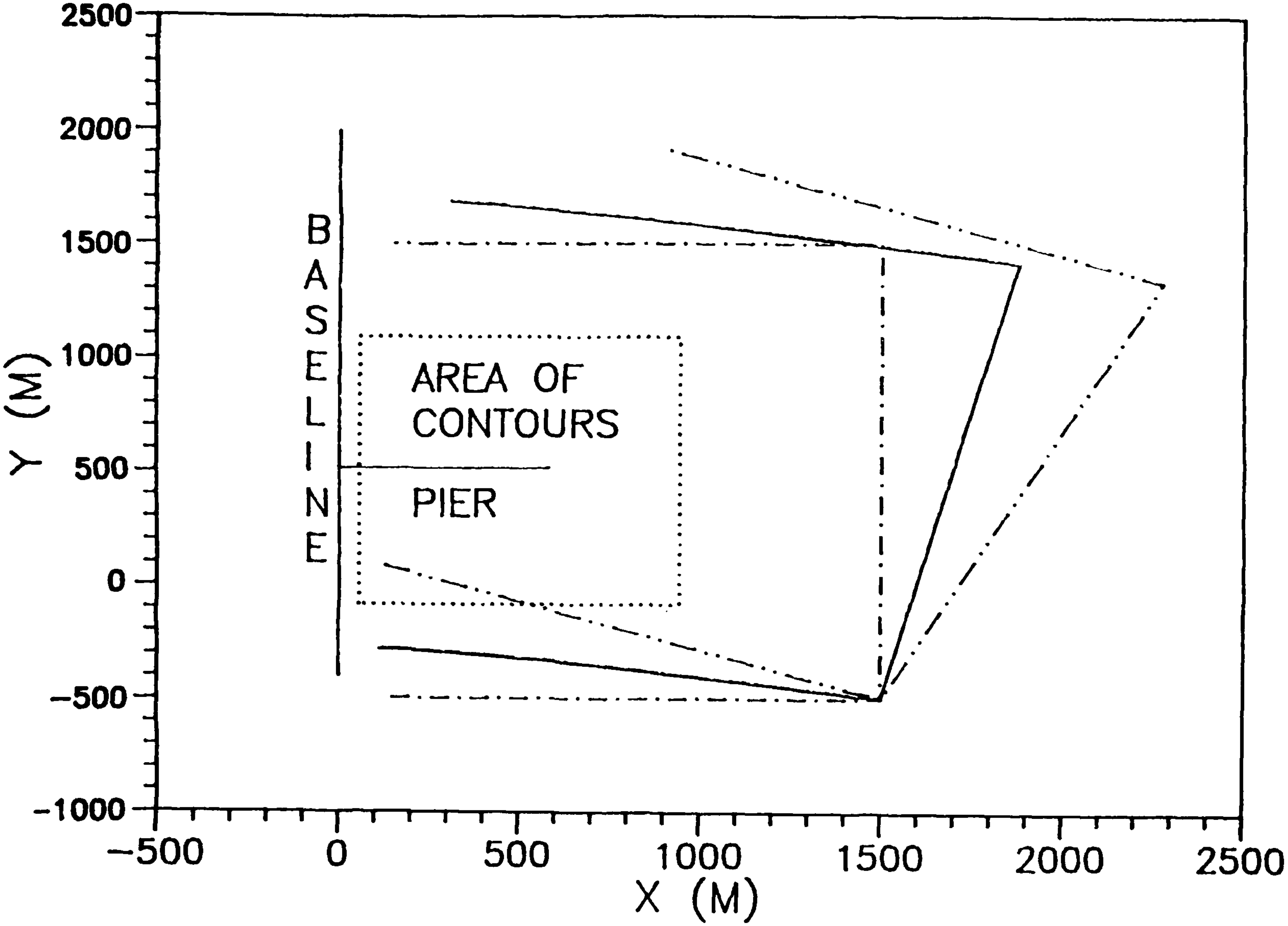


Figure 3.10 Computational Domains for Three Numerical Models

Bathymetric data, in digitized form, were provided by the CERC. For the bathymetry measured on October 16, 1982, depth data were given at each nodal point of a 75 X 50 grid mesh; the grid sizes were $\Delta x = 12m$ and $\Delta y = 24m$. Bathymetry contours for this survey are presented in Figure 3.7. For the bathymetry measured on October 27, 1982, digitized water depths were available for the nearshore portion of the same grid mesh; however, the seawardmost 22 grid lines were not available. Water depths beyond the last surveyed point in the offshore direction was assumed to remain unchanged since October 16, 1982. The "composite" bathymetry used to represent conditions on October 27 is shown in Figure 3.8. Note that there is a significant depression in the bottom topography near the tip of the pier for both data sets. Field measurements of the incident wave parameters and tide elevation for each test case are also summarized in Table 3.3.

In all computations, grid sizes of $\Delta\sigma = \Delta\rho = 10m$ have been used so that the topographical variations are well represented in the models. Comparisons between field measurements and numerical results from all three models are given in Figure 3.9. Numerical results obtained from the fixed Cartesian coordinate model and from the curvilinear coordinate model agree reasonably well with the field data. The results from the rotated Cartesian coordinate model become invalid in the shallow water because the effects of lateral boundaries have reached the pier see (Figure 3.10). This shortcoming could be remedied by enlarging the computational domain and by creating artificial water depth data near the shore. The required CPU times for different runs are listed in Table 3.4.

Case	Coordinates Option		
	Curvilinear	Rotated Cartesian	Fixed Cartesian
1	0.35	0.08	0.06
2	0.35	0.08	0.06
3	0.29	0.08	0.06
4	0.15	0.20	0.05
5	0.29	0.08	0.05
6	0.29	0.08	0.05

Table 3.4 Computing Cost for CERC cases (CPU Time, Hour)

3.4 Wave Propagating Over Currents

Because the lack of high quality laboratory and field experimental data for the wave-current interaction problem, the present model is applied to a theoretical problem which was originally studied by Authur (1950). Later this problem was re-investigated by Liu (1983) and Kirby et al. (1984). As shown in Figure 3.11, a rip- current system exists on a uniform sloping beach with a slope of 0.02. The current velocity is described as

$$u = 0.144 \; x \; F\left(\frac{x}{250}\right) F\left(\frac{y}{25}\right) \tag{3.5}$$

$$v = -3.60 \left[2 - \left(\frac{x}{250}\right)^2\right] F\left(\frac{x}{250}\right) \int_0^{y/25} F(\alpha)\, d\alpha \tag{3.6}$$

with

$$F(\alpha) = \frac{1}{\sqrt{2\pi}} \exp\left(-\alpha^2/2\right) \tag{3.7}$$

where the length and the time units are in feet and seconds, respectively.

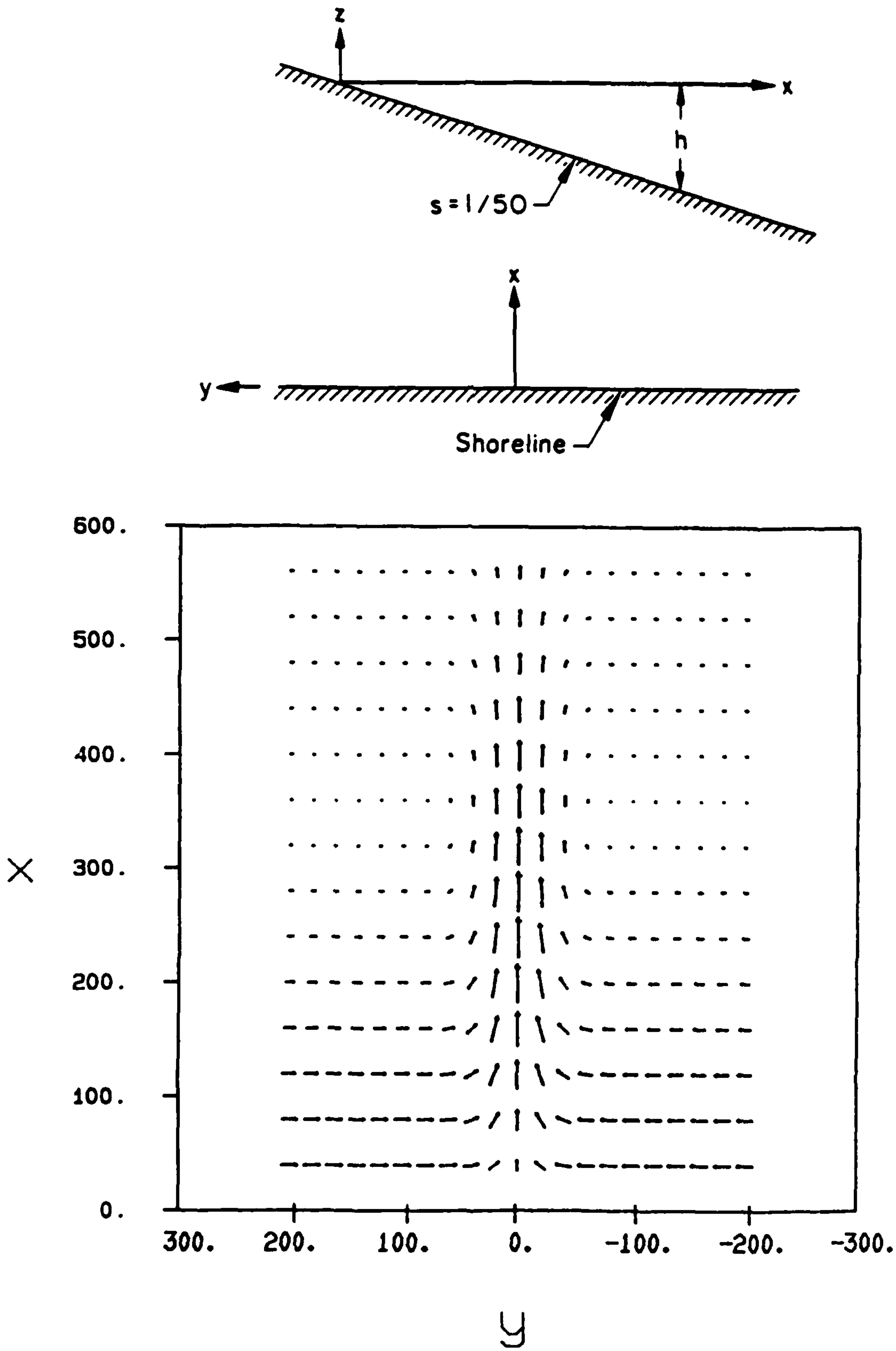


Figure 3.11 Sketch of Beach Geometry and Rip Current Pattern (Authur 1950)

Authur (1950) constructed a set of wave rays for a train of monochromatic waves with an 8 second periods. The wave rays are shown in Figure 3.12. Due to the wave refraction over an opposing current, many crossings appear over currents. Therefore, the linear ray theory is not applicable to this problem.

Because the incident angle is 0^0, only the model using fixed Cartesian Coordinates is applicable. The calculated wave amplitude distributions along different sections are shown in Figure 3.13, normalized by the amplitude, a_o = 1 ft at x = 1000 ft from the shoreline. In the numerical computations, a unifrom gird system is used; $\Delta x = \Delta y = 10$m. The present numerical results are in excellent agreement with those obtained by Liu (1983); the differences between these two sets of results are not plottable. Amplitudes due to shoaling without the effects of currents, are shown in Figure 3.13f. Excellent agreement is also demonstrated.

It is apparent the wave amplitude becomes very large due to the focusing of wave energy by opposing current. The criterion of wave breaking, (2.62), is applied in this case to simulate the transformation of waves in the surf zone (see Figure 3.13). The wiggles appearing in the wave amplitude in the surf zone seems to suggest that the breaking wave criterion used in the model over-estimate the local energy dissipation.

In the numerical computation, current fields are digitalized into files of CURRNX.DAT and CURRNY.DAT. Together with input files DEPTH.DAT, LOC.DAT, IN.DAT and sample output file OUT01.DAT, they are shown in the Appendix D.

3.5 Waves Around Breakwaters

The present models can be applied to calculate the wave field in the neighborhood of multiple breakwaters. For the purpose of model verification

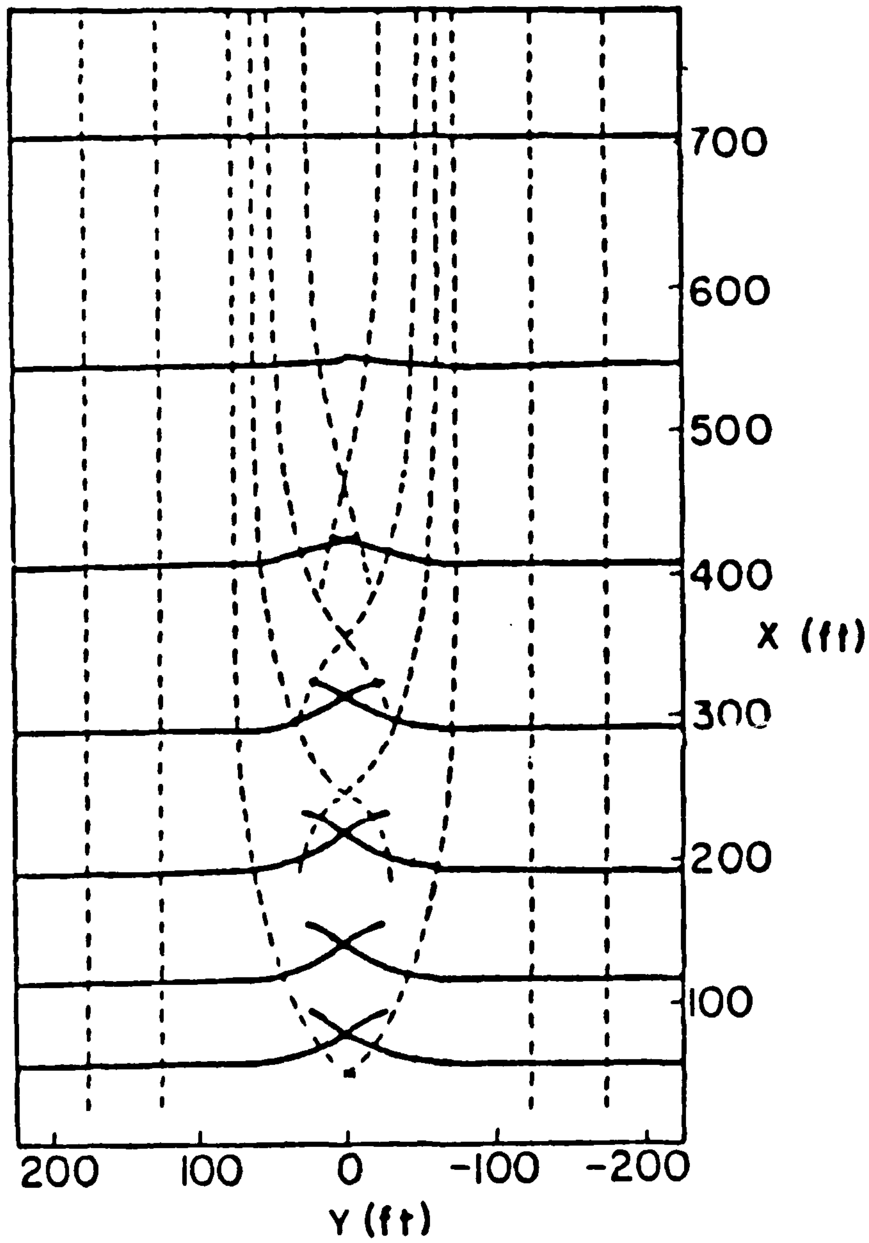


Figure 3.12 Wave Ray Pattern (Authur 1950)

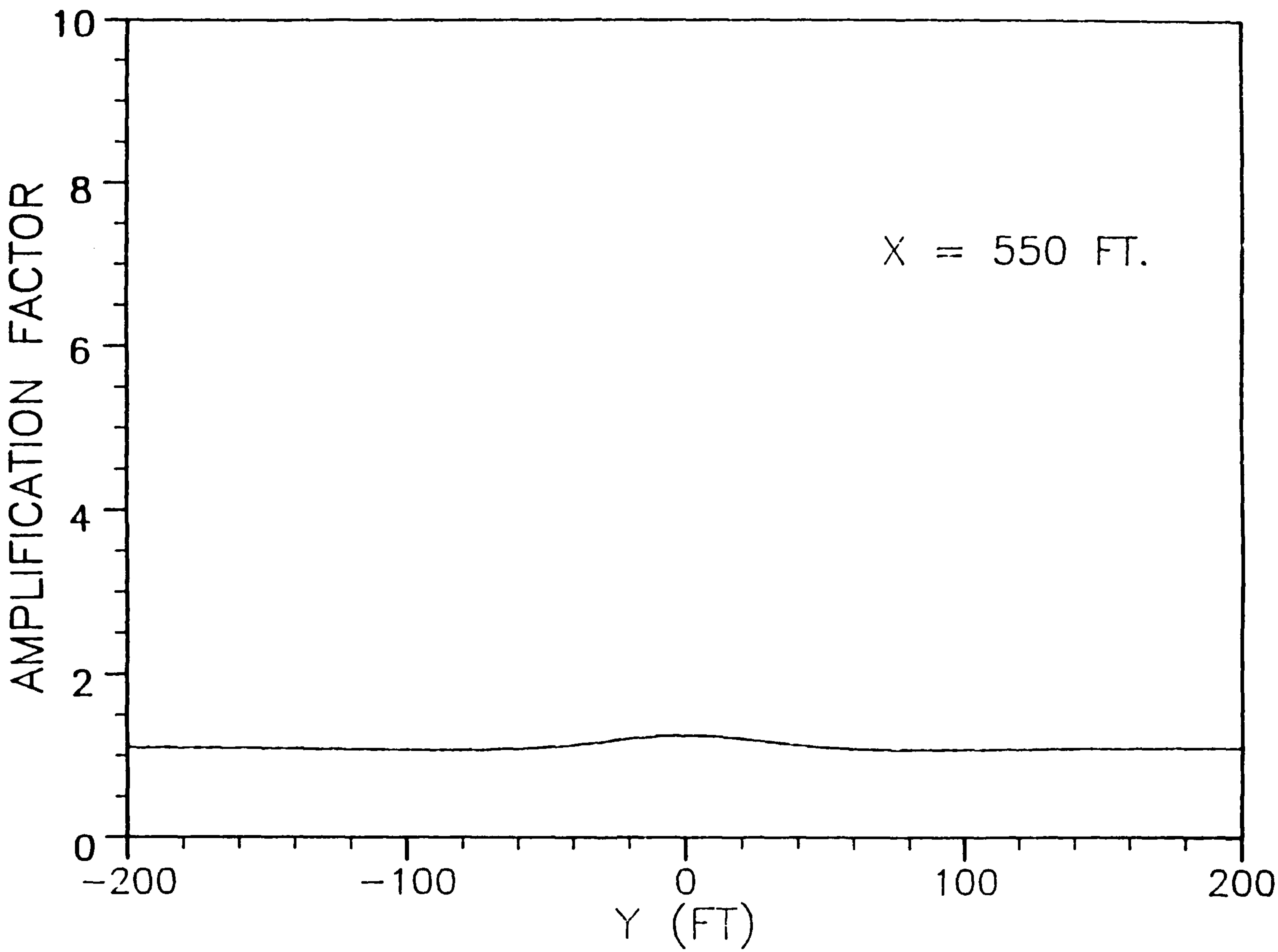


Figure 3.13a Numerical Results of Normalized Wave Amplitude; —— Without Wave Breaking; —·—·— With Wave Breaking; ········Shoaling only.

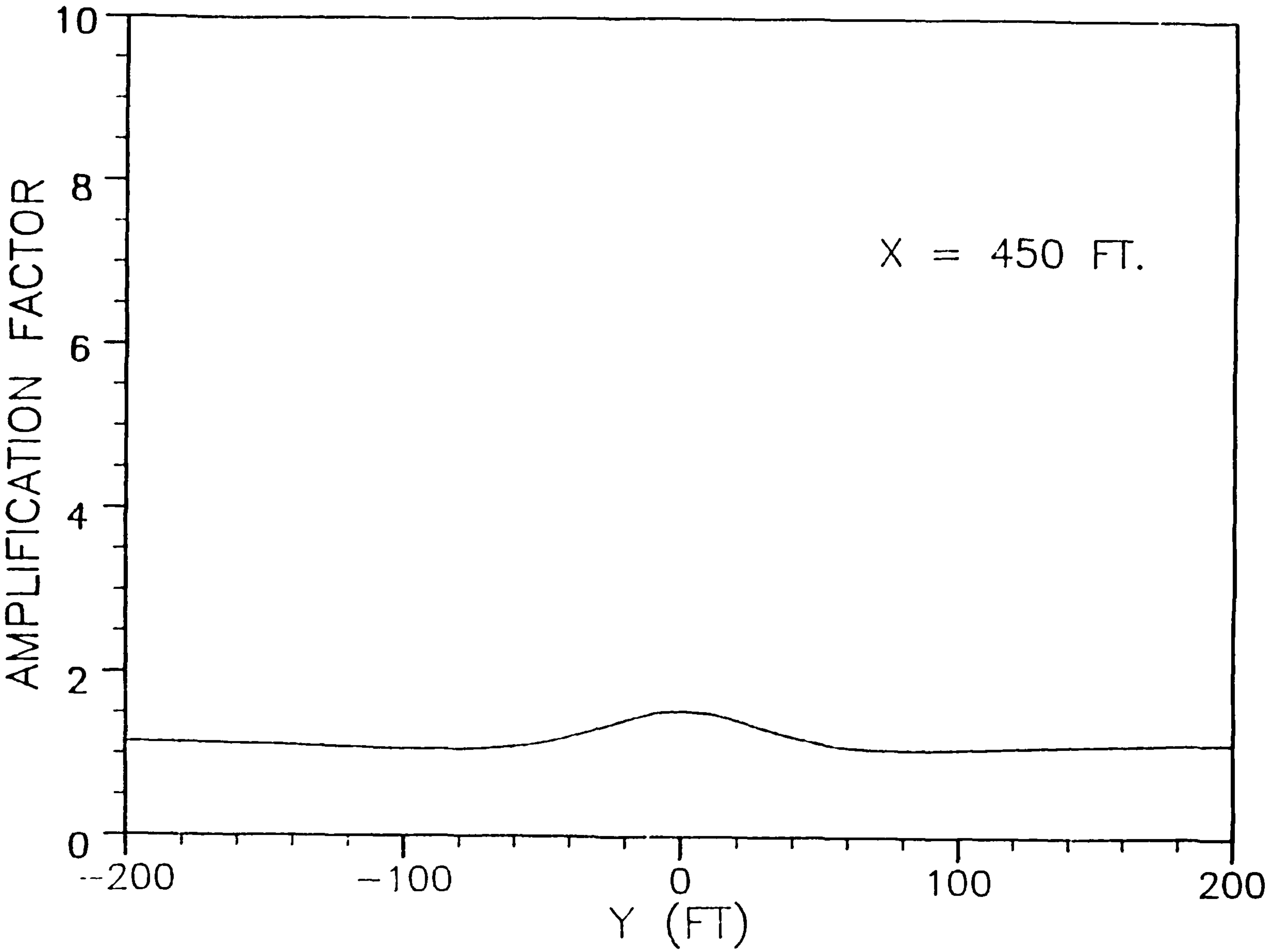


Figure 3.13b Numerical Results of Normalized Wave Amplitude; —— Without Wave Breaking; —·—·— With Wave Breaking; ······· Shoaling only.

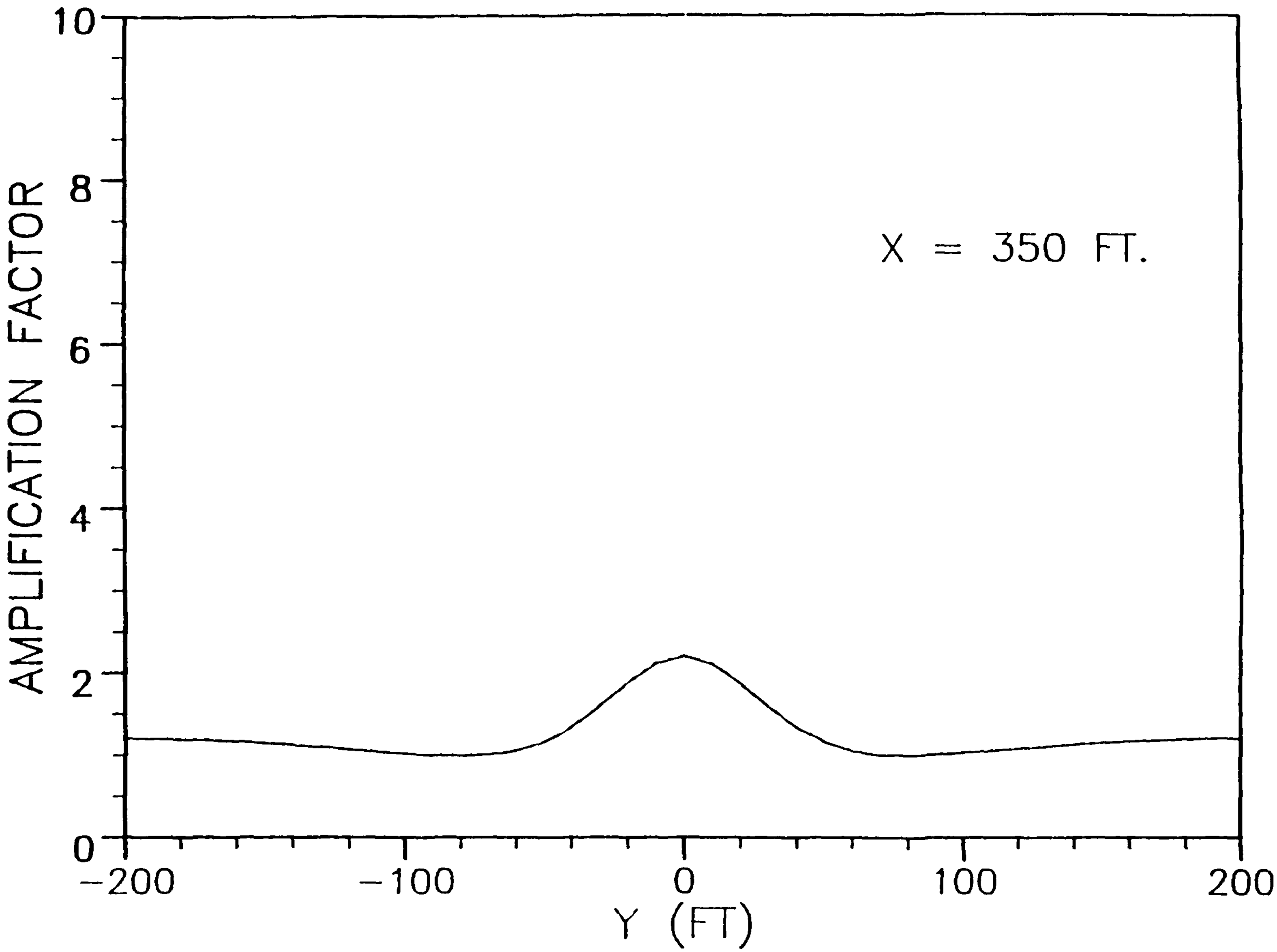


Figure 3.13c Numerical Results of Normalized Wave Amplitude;—— Without Wave Breaking; —·—·— With Wave Breaking; ········ Shoaling only.

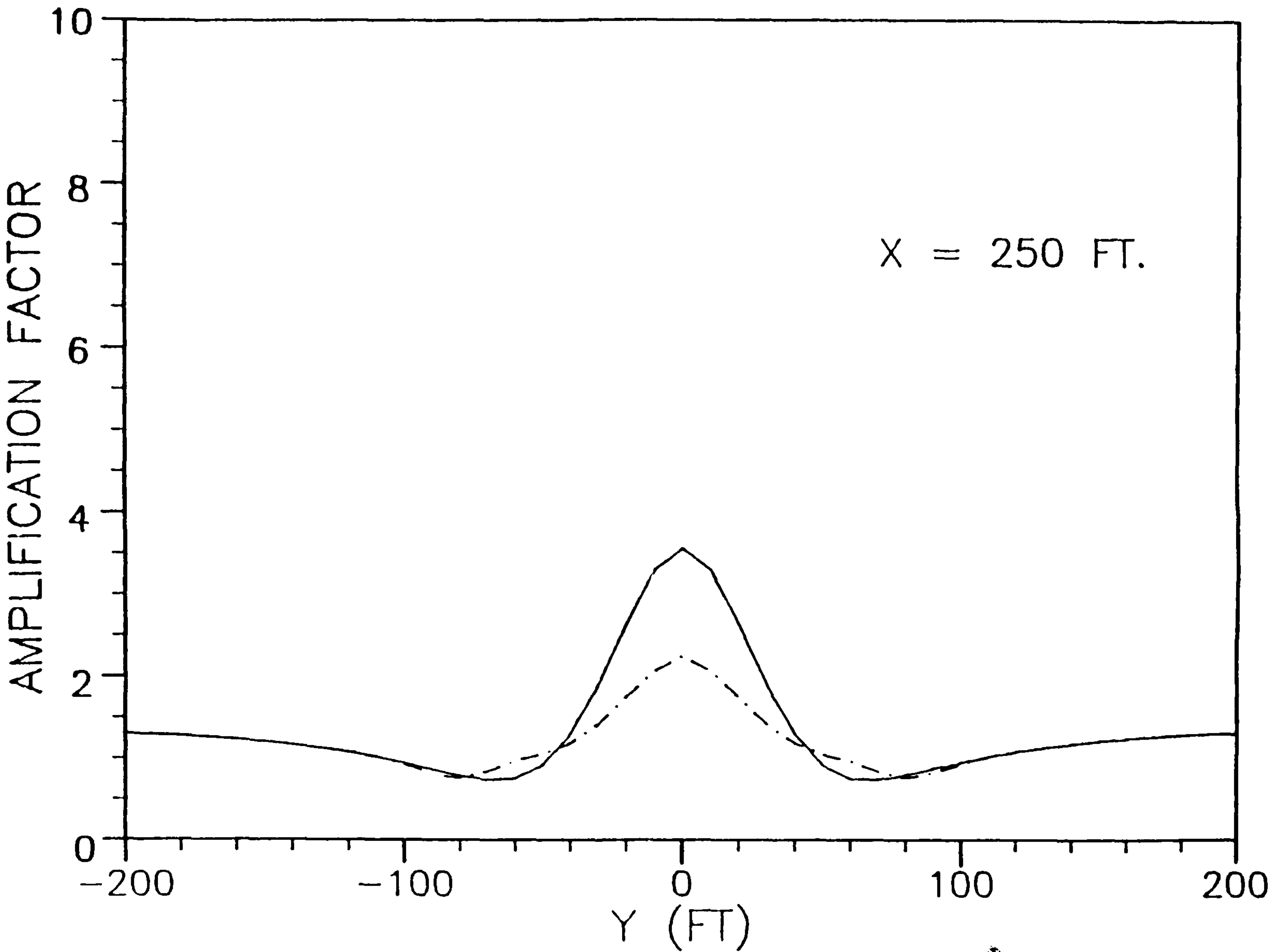


Figure 3.13d Numerical Results of Normalized Wave Amplitude;—— Without Wave Breaking; —·—·— With Wave Breaking; ········ Shoaling only.

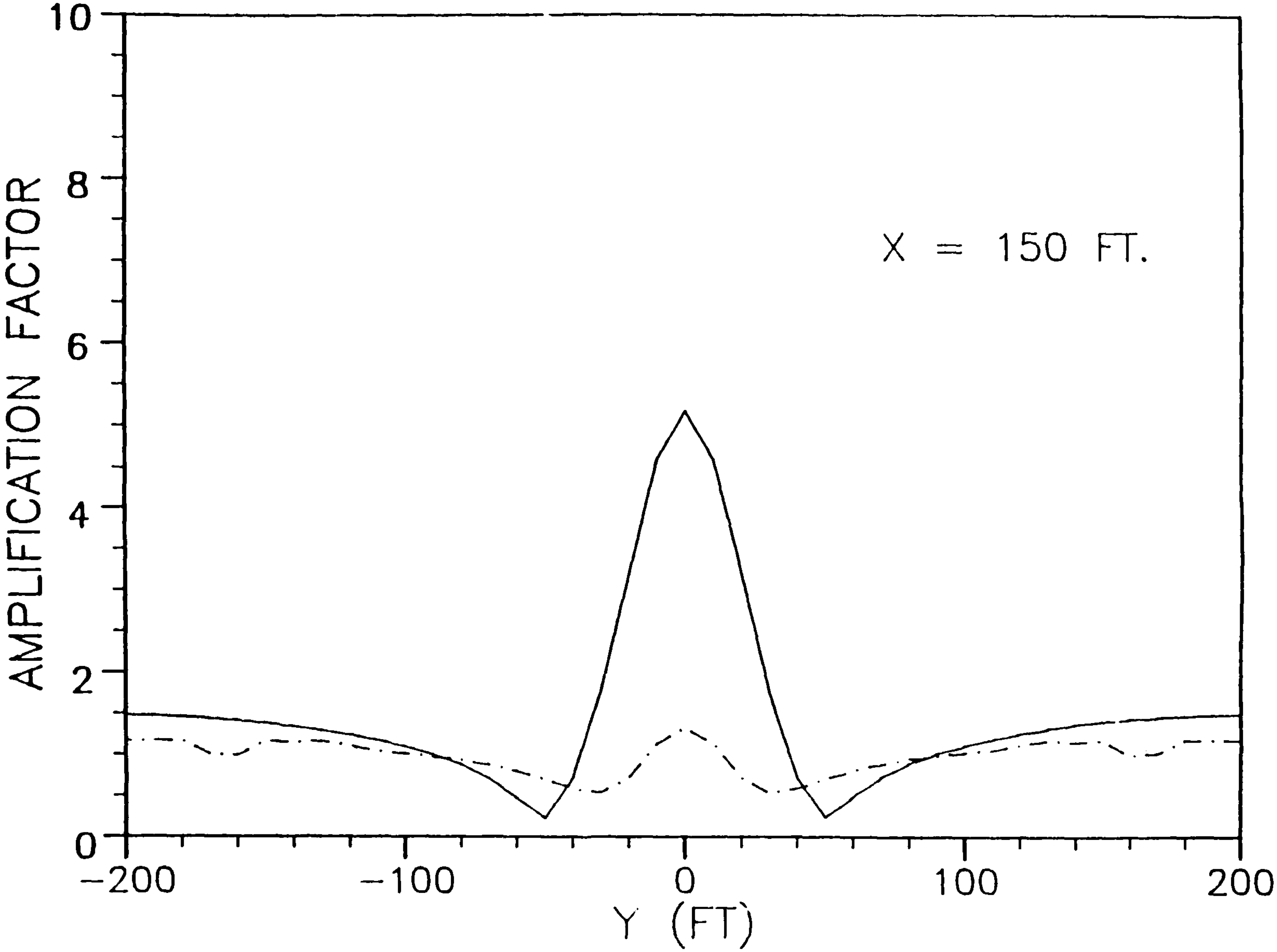


Figure 3.13e Numerical Results of Normalized Wave Amplitude; —— Without Wave Breaking; —·—·— With Wave Breaking; ········· Shoaling only.

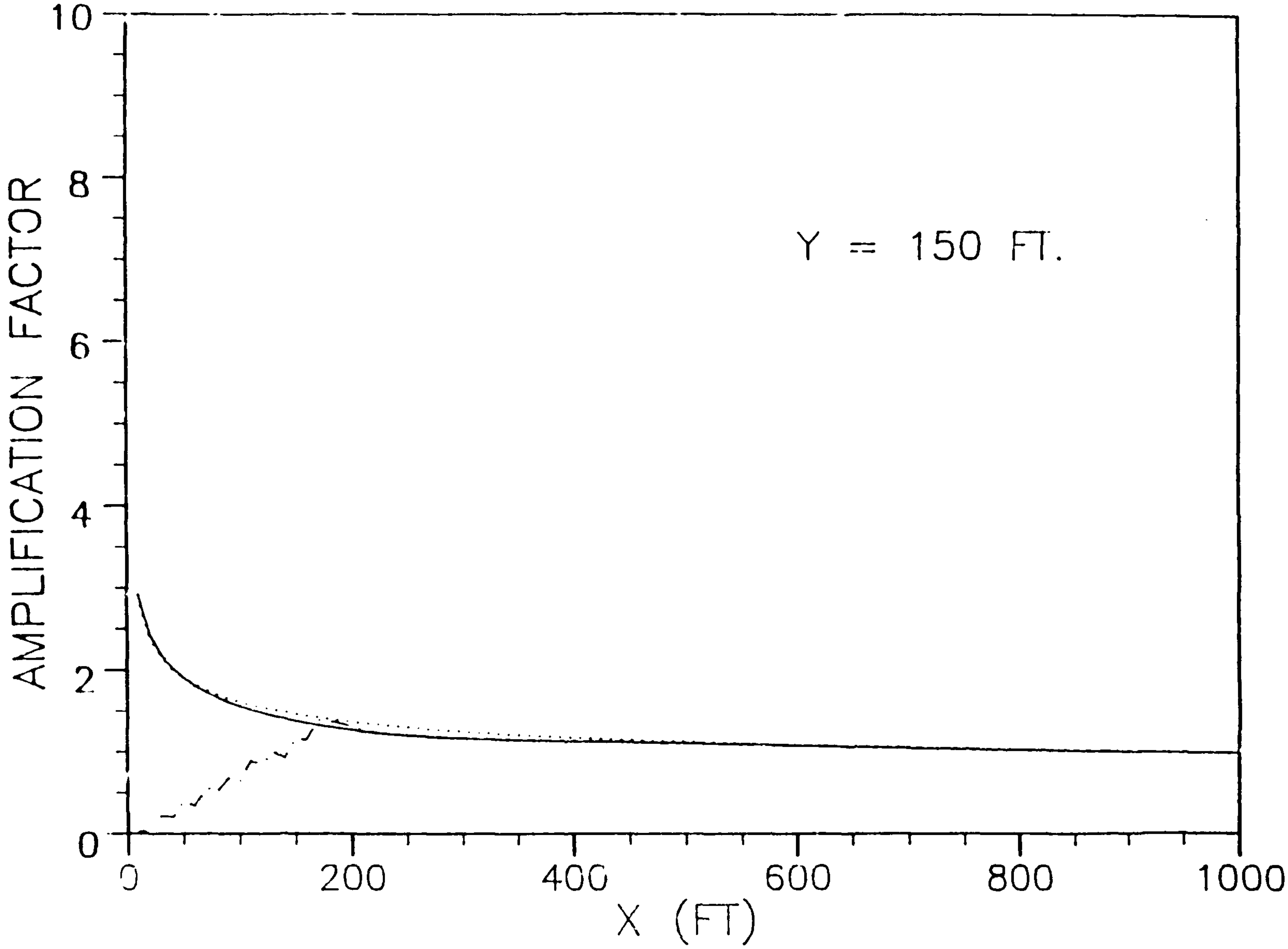


Figure 3.13f Numerical Results of Normalized Wave Amplitude; ——— Without Wave Breaking; —·—·— With Wave Breaking; ·········· Shoaling only.

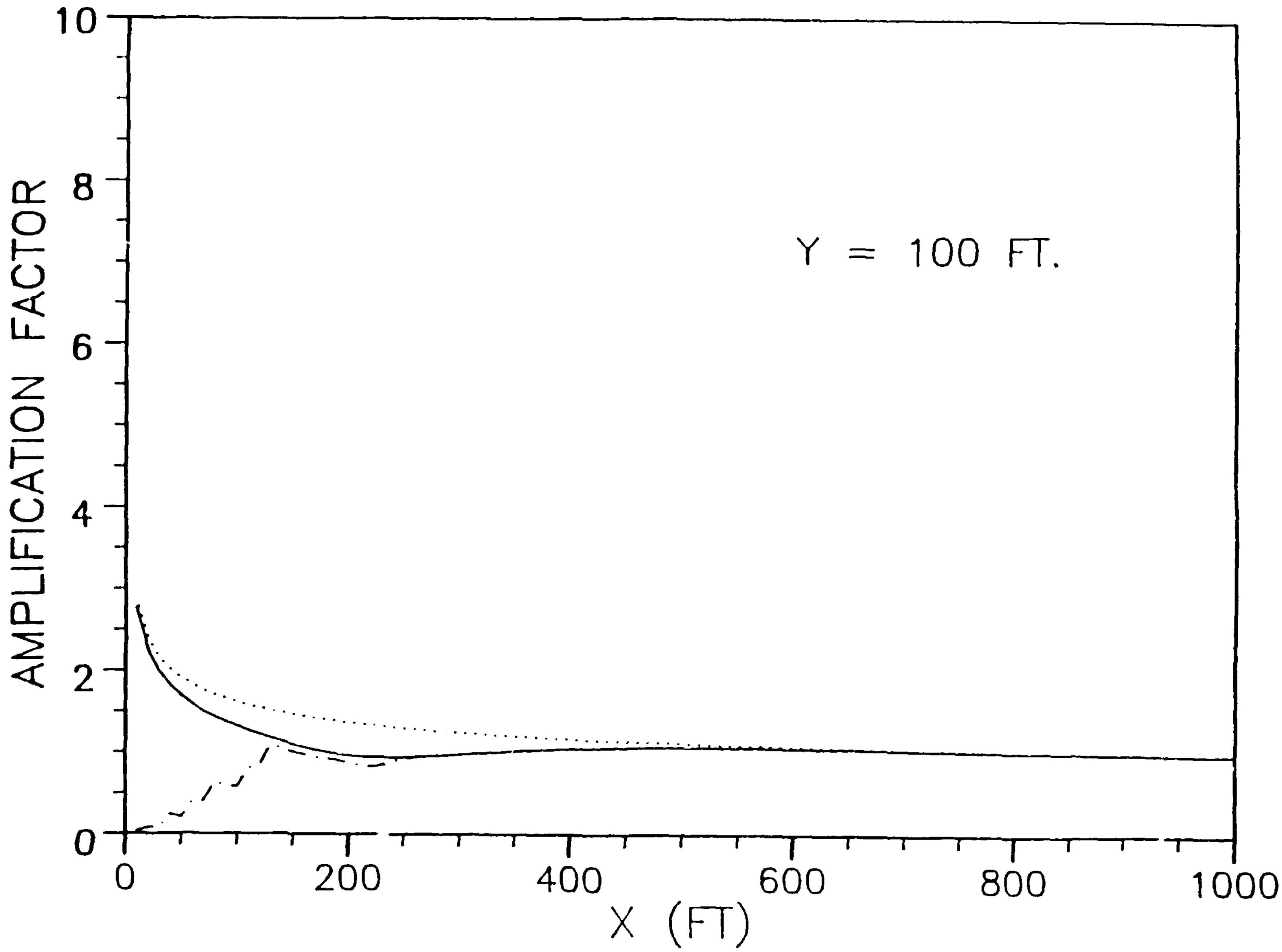


Figure 3.13g Numerical Results of Normalized Wave Amplitude; —— Without Wave Breaking; —·—·— With Wave Breaking; ·········Shoaling only.

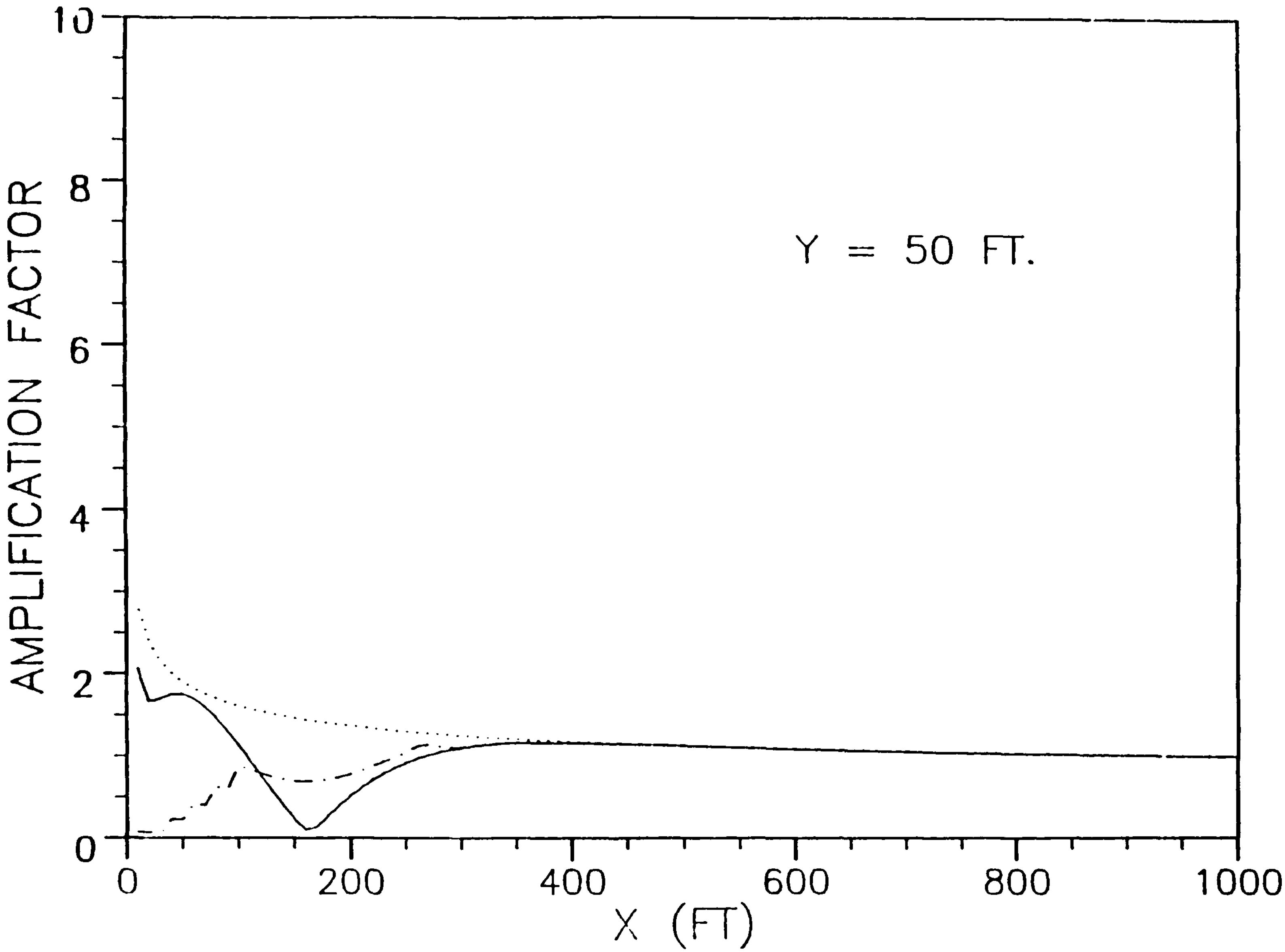


Figure 3.13h Numerical Results of Normalized Wave Amplitude; ——— Without Wave Breaking; —·—·— With Wave Breaking: ········· Shoaling only.

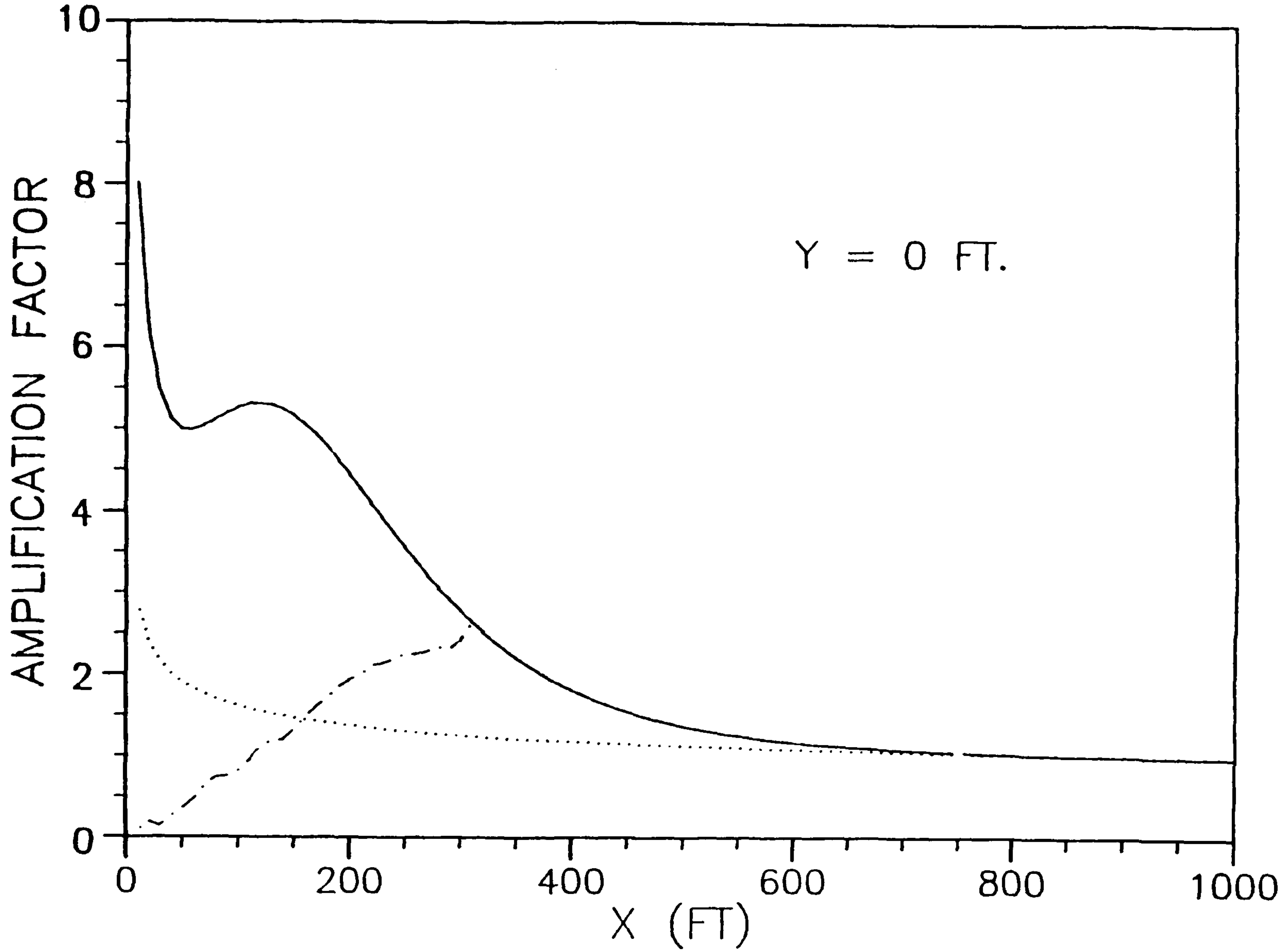


Figure 3.13i Numerical Results of Normalized Wave Amplitude;——— Without Wave Breaking; —·—·— With Wave Breaking; ·········Shoaling only.

cases with available experimental measurements are investigated. For the single breakwater case, a thin breakwater with zero thickness is installed on a uniform sloping beach. The breakwater can be perpendicular to or inclined to the shoreline, that is, θ_B equals 0^0 or 30^0 in Figure 3.14, respectively (Hales, 1980).

In the case of a perpendicular breakwater with wave period, T = 1.0 second and incident angle, $\theta^o = 20^0$, present numerical results are compared with laboratory measurements (Hales, 1980) at two cross-sections, x = 12.5 ft and 9 ft (Figure 3.15). We remark that the present results are calculated for both the upwave and downwave sides of the breakwater simultaneously, which is different from the procedures used by Tsay and Liu (1982). All of the numerical results are comparable to those of laboratory measurements. It is also observed that the computational domain of the rotated Cartesian coordinate system is limited and therefore part of the wave amplitude field along x = 9 ft is not available. In order to obtain better resolution of the numerical results, $\Delta\sigma = \Delta\rho = 0.25$ ft are used even though grid sizes of $\Delta\sigma = \Delta\rho = 0.5$ ft already satisfy the numerical stability criterion, (2.59).

For waves with a period, T = 1.0 second and incident angle, $\theta_o = 30^0$, the wave field around an inclined breakwater, $\theta_B = 30^0$, is calculated and compared only with available, experimental measurements in the downwave side at four cross-sections, x = 12 ft, 10 ft, 8 ft and 6 ft. Comparison of present numerical results with laboratory measurements are shown in Figure 3.16. The grid size of $\Delta\sigma = \Delta\rho = 0.25$ ft are used in the numerical computations. The boundary condition, (2.49), for rotated Cartesian coordinate, have violated the stability criterion, (2.59). Its results near the breakwater are not very accurate. On the upwave (reflected) side of the breakwater, results using the curvilinear coordinate system seem to oscillate

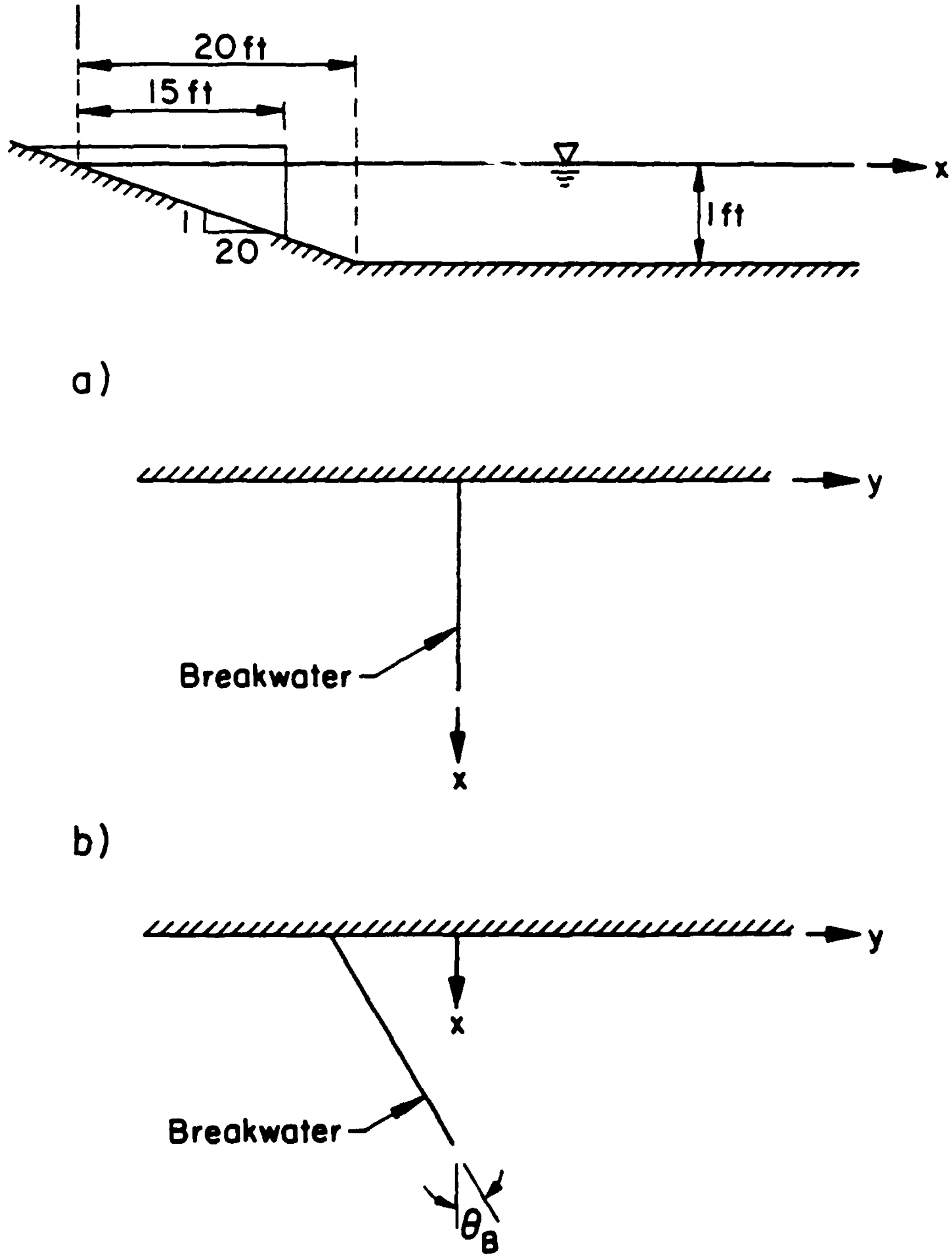


Figure 3.14 Sketch of Beach Geometry with a Breakwater (a) Perpendicular Breakwater, $\theta_B=0$; (b) Inclined Breakwater, $\theta_B=30^o$.

with an inaccurate frequency. It may be due to the fact that the ray-phase line system of incident waves is quite different from that of reflected waves.

It is common practice in shoreline protection to use two breakwaters to maintain sufficient depths for navigation purposes. A laboratory set-up as shown in Figure 3.17 was constructed to study the wave field inside two breakwaters (Isobe 1986). The incident wave period is 0.83 seconds and the incident angle in the constant depth region is -18^0. Grid sizes, $\Delta\sigma = \Delta\rho =$ 0.02m are used in curvilinear and rotated Cartesian coordinates. To assure that the change of number of grid points on either side of breakwater is limited to one at each marching step, $\Delta\sigma = 0.04$m and $\Delta\rho = 0.05$m are used in fixed Cartesian coordinate systems. The wave amplitude distribution of the numerical results are compared with experimental measurements at sections AA and BB (Figure 3.18). Due to the large inclinational angle in the section from the tip of breakwaters and short wave period, the grid sizes are much smaller than those used in the other two cases. The stability criterion, (2.59) is not satisfied on the inclinational section of the breakwater, AB (see Figure 3.17) in rotated Cartesian coordinate systems, therefore its numerical results in the vicinity of the breakwater, AB are not accurate. However, both models of curvilinear coordinate and fixed Cartesian coordinate system provide with good results within the area between two breakwaters.

Samples of input/output data files are shown in Appendix E.

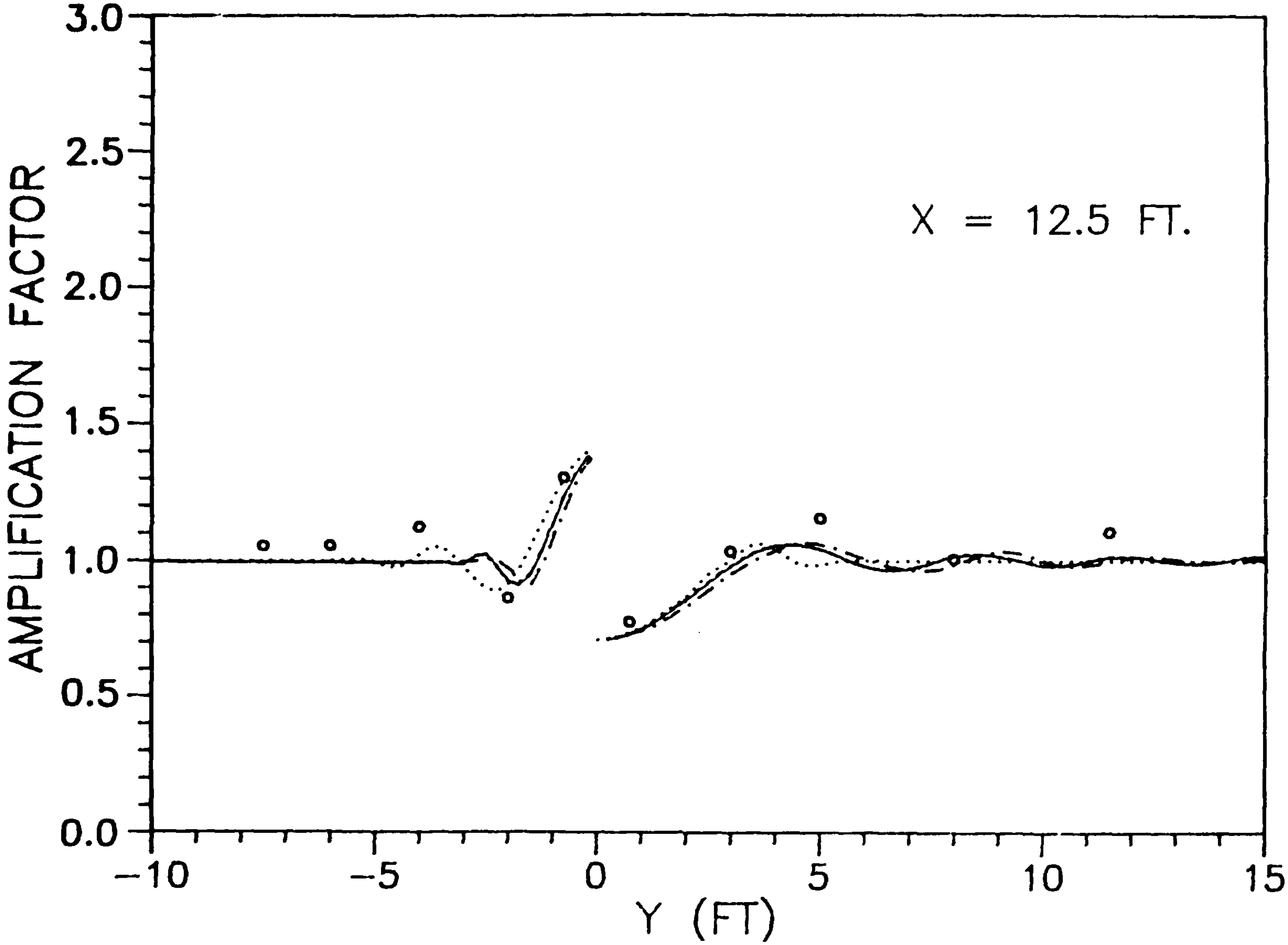


Figure 3.15a Comparison of Normalized Wave Amplitude with Experimental Measurement; o o o: Measurements, ——: Curvilinear Coordinates, —·—: Rotated Cartesian Coordinates; ········: Fixed Cartesian Coordinates.

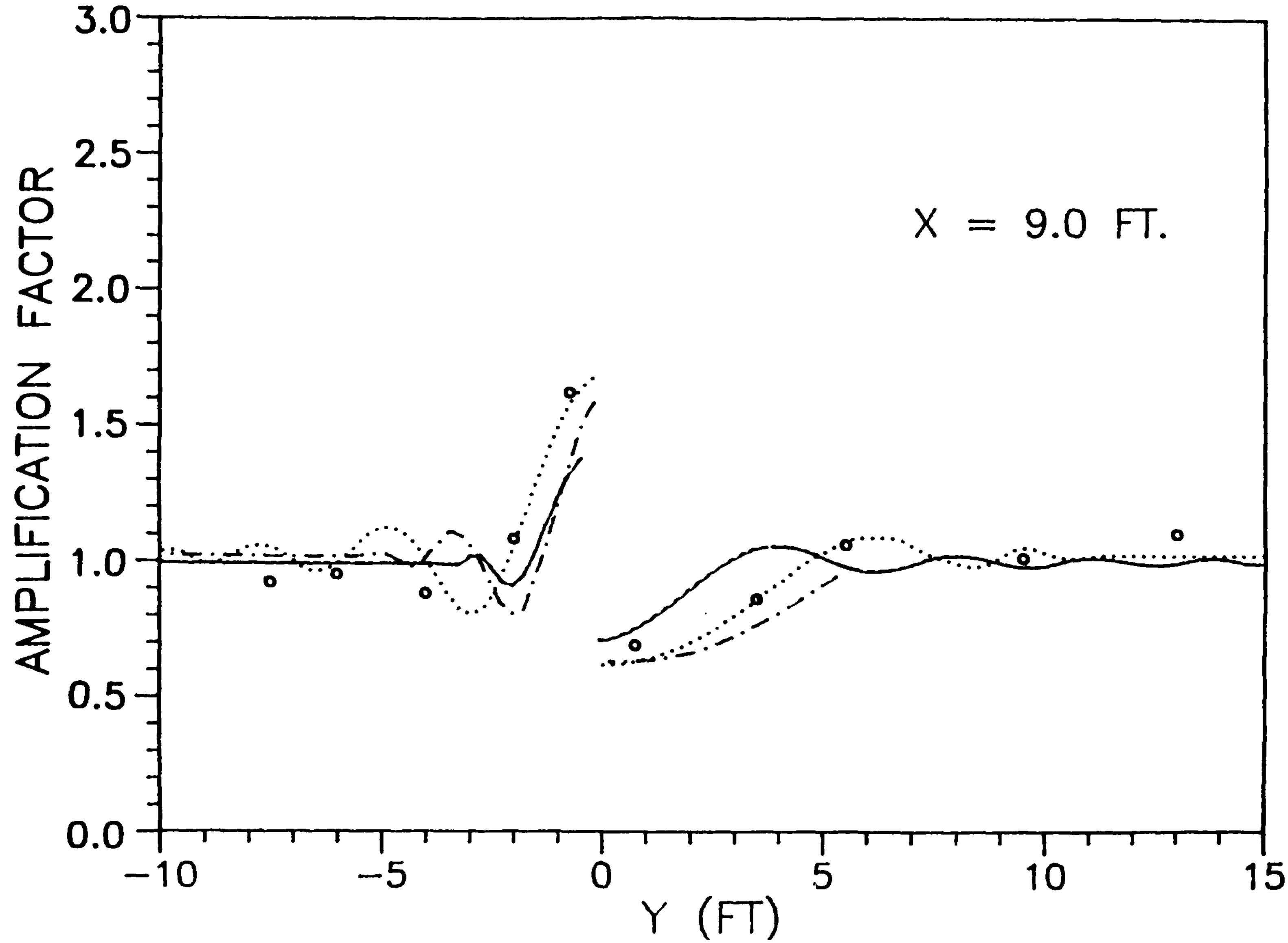


Figure 3.15b Comparison of Normalized Wave Amplitude with Experimental Measurement; o o o: Measurements, ——: Curvilinear Coordinates, —·—: Rotated Cartesian Coordinates; ·········: Fixed Cartesian Coordinates.

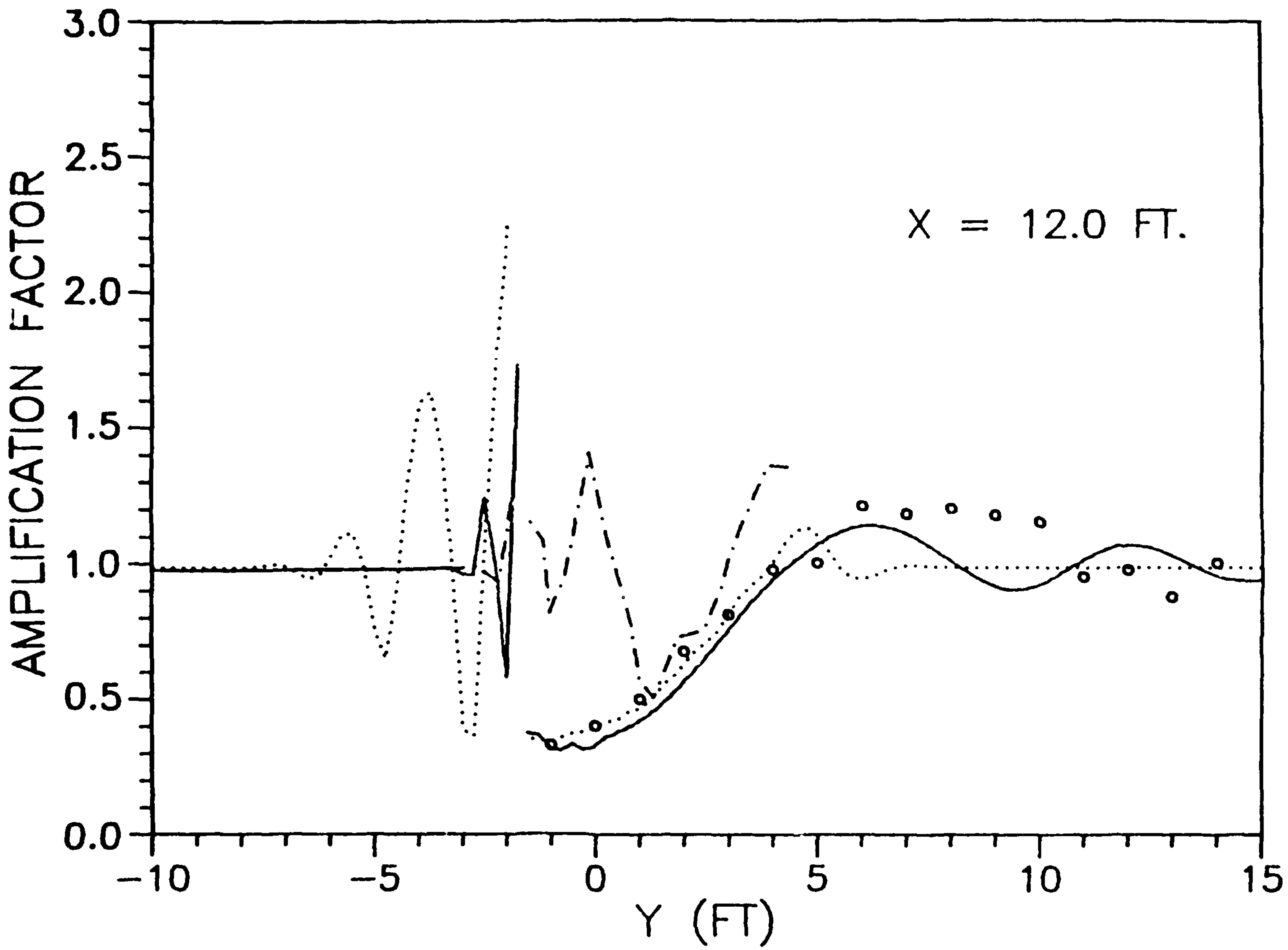


Figure 3.16a Comparison of Normalized Wave Amplitude with Experimental Measurements: o o o Measurements, ———: Curvilinear Coordinates; —·—: Rotated Cartesian Coordinates; ········: Fixed Cartesian Coordinates.

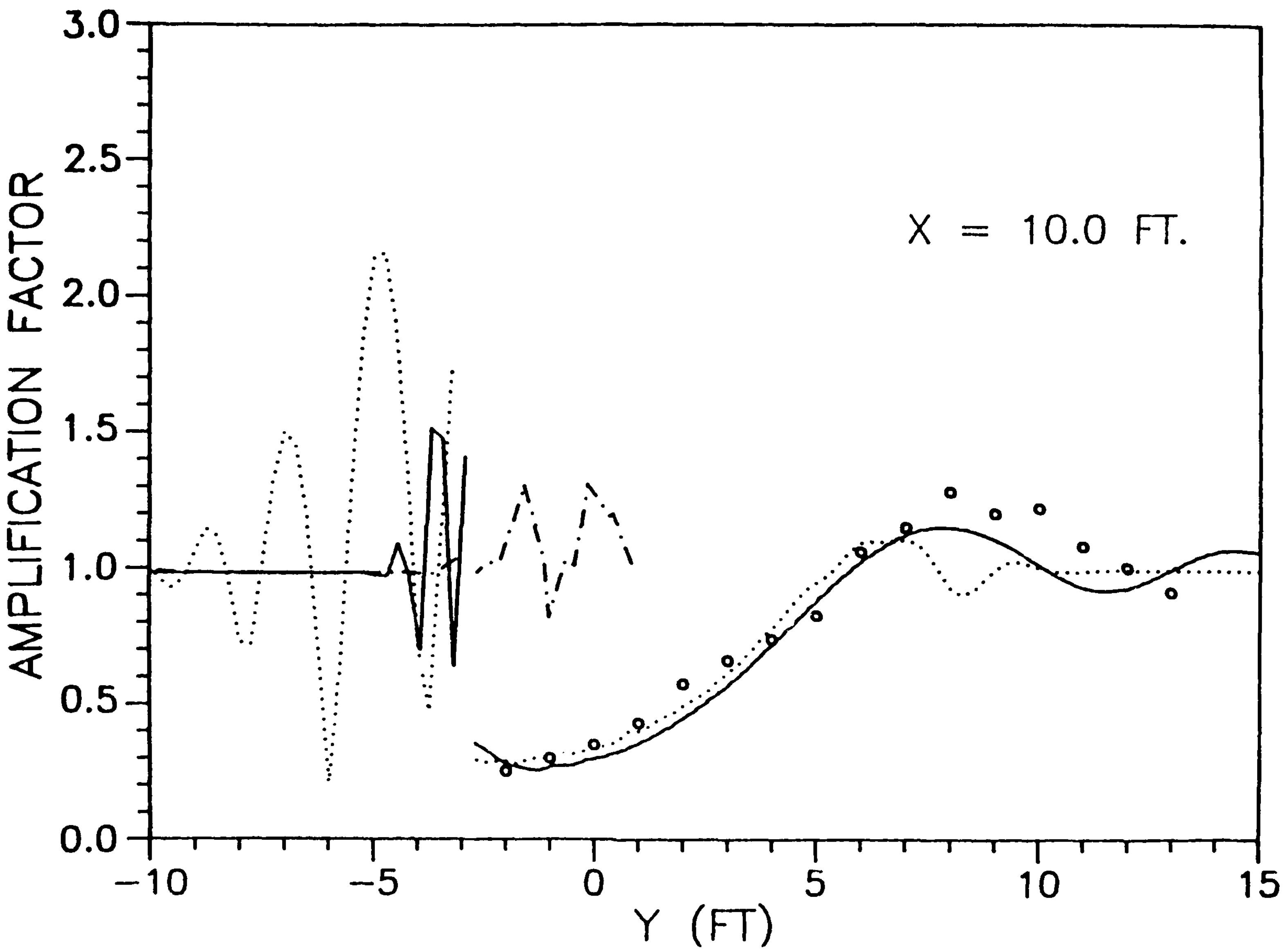


Figure 3.16b Comparison of Normalized Wave Amplitude with Experimental Measurements: o o o Measurements, ——: Curvilinear Coordinates; — · —: Rotated Cartesian Coordinates; ·······: Fixed Cartesian Coordinates.

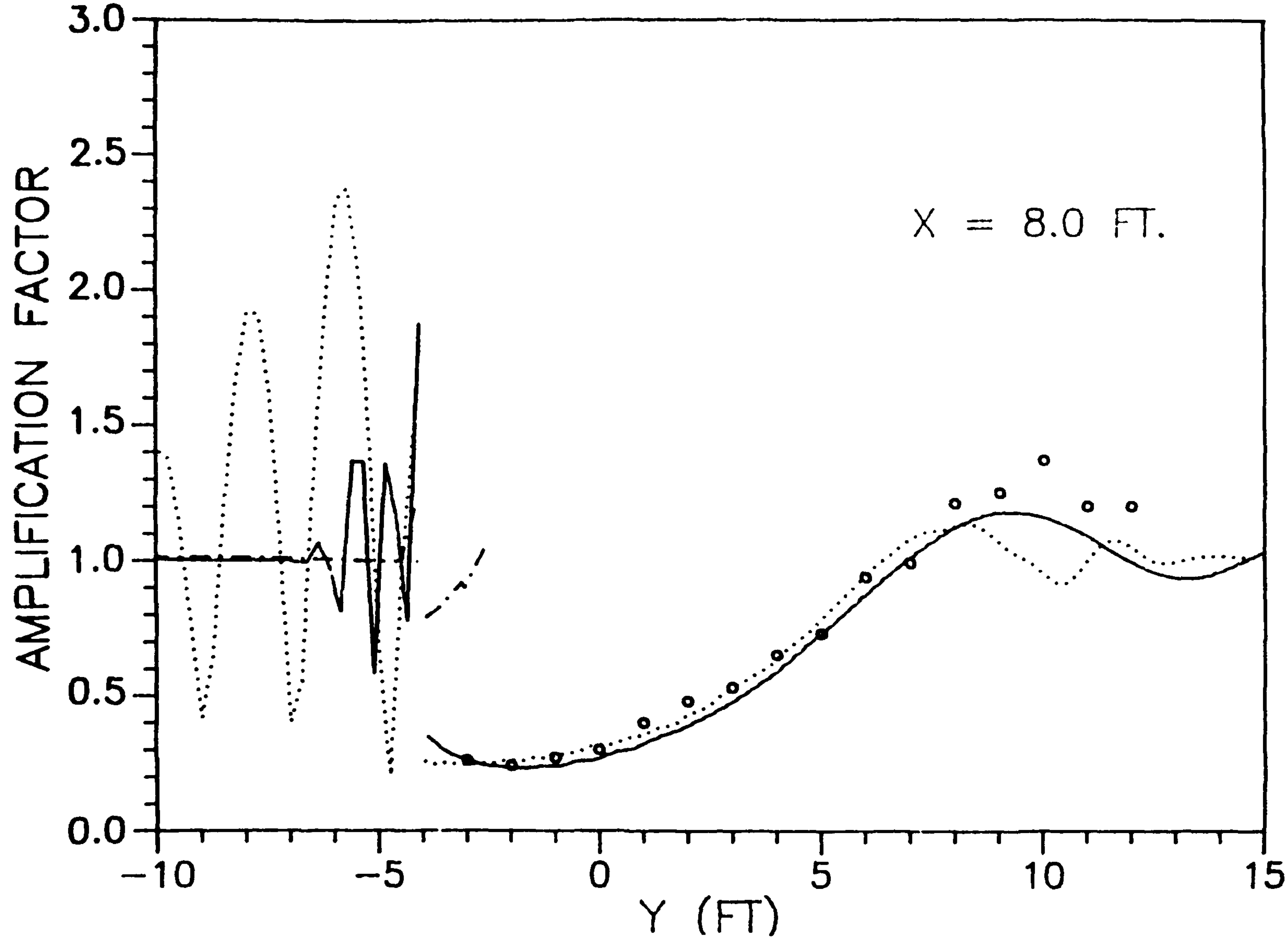


Figure 3.16c Comparison of Normalized Wave Amplitude with Experimental Measurements: o o o Measurements, ——: Curvilinear Coordinates; —·—: Rotated Cartesian Coordinates; ·······: Fixed Cartesian Coordinates.

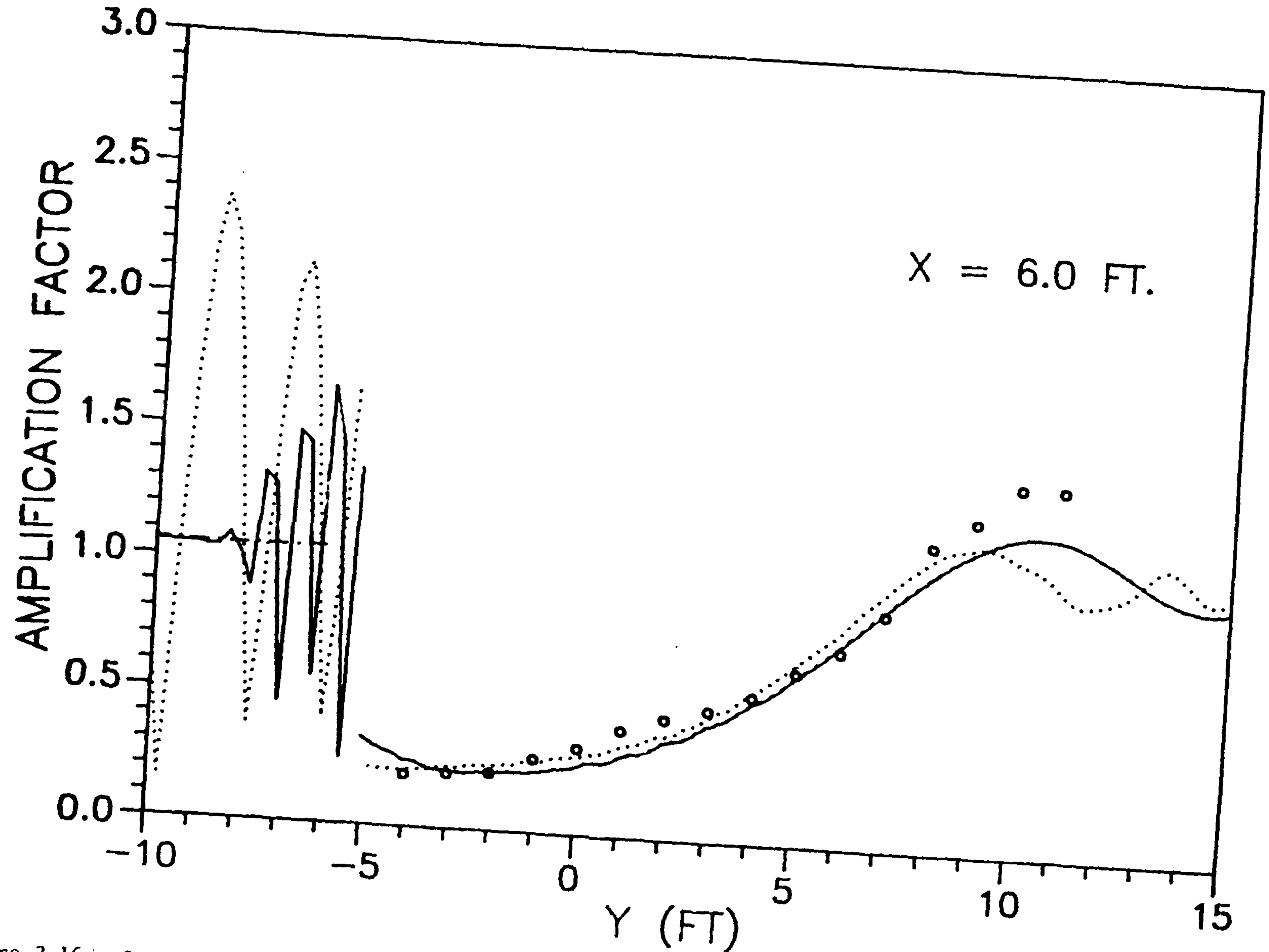


Figure 3.16a Comparison of Normalized Wave Amplitude with Experimental Measurements: o o o Measurements, ——: Curvilinear Coordinates; —·—: Rotated Cartesian Coordinates; ⋯⋯: Fixed Cartesian Coordinates.

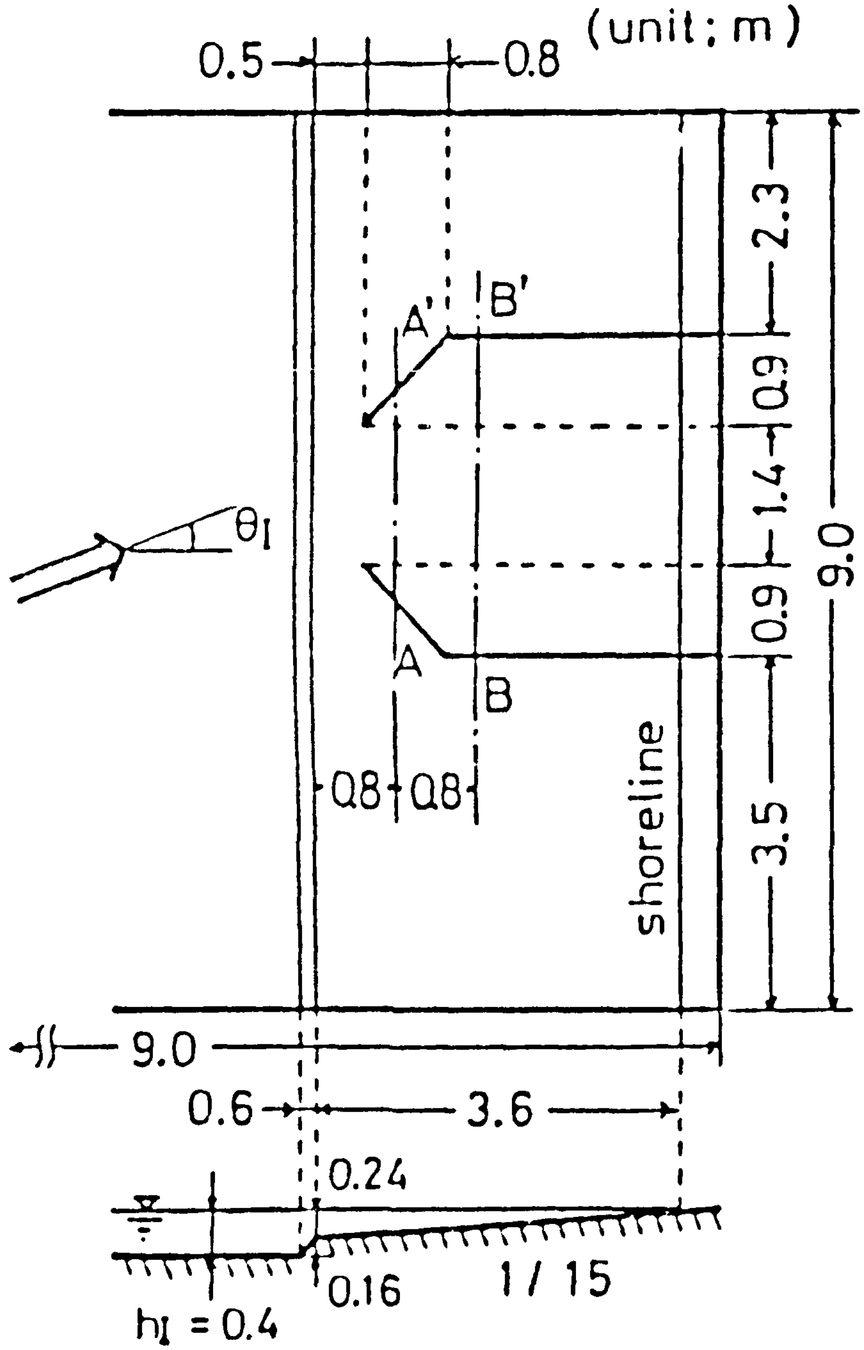


Figure 3.17 Laboratory Set-up of Two Breakwaters on a Plane Beach

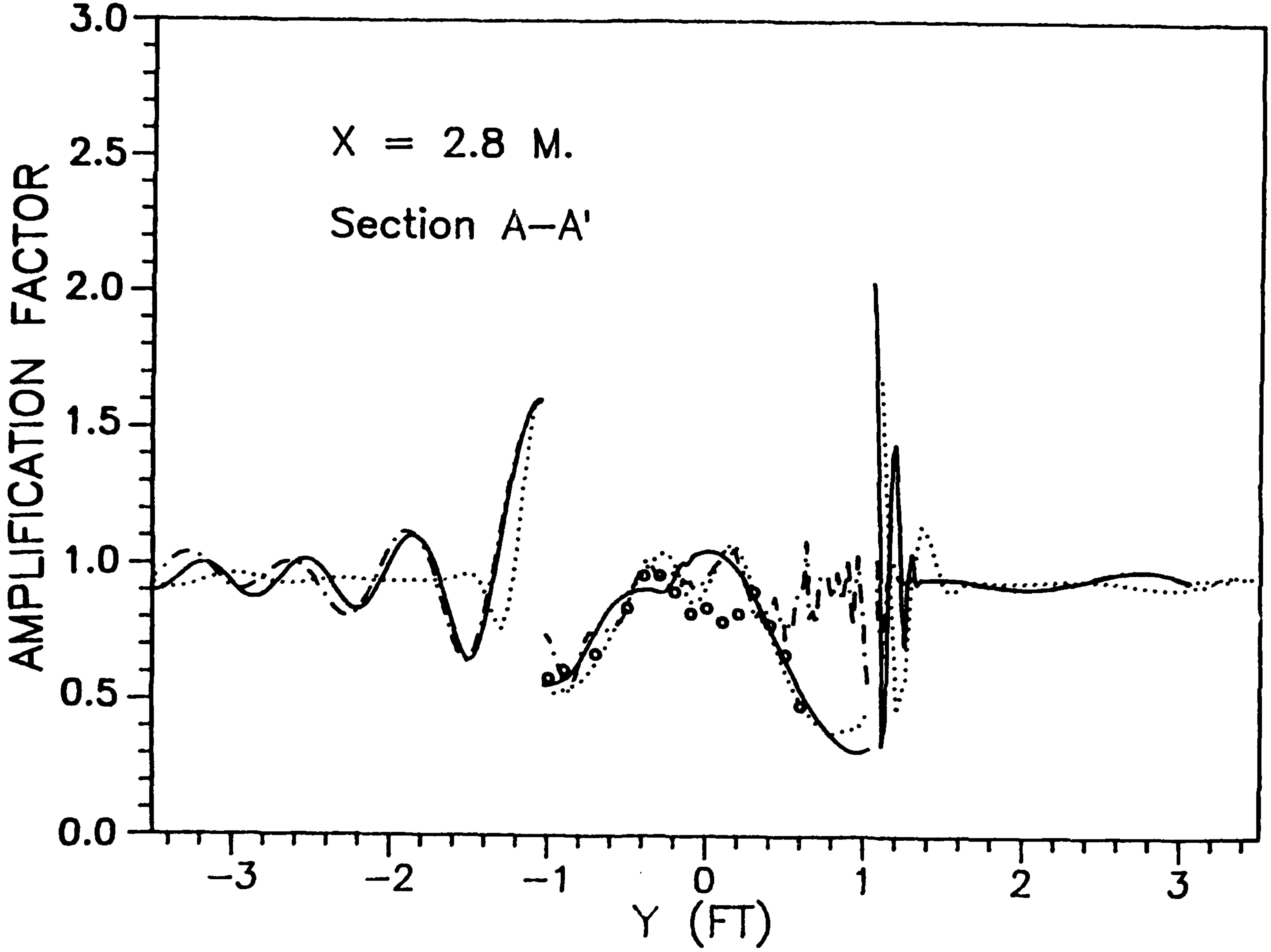


Figure 3.18a Comparison of Numerical Results with Experimental Measurement; o o o: Measurements, ——: Curvilinear Coordinates; —·—: Rotated Cartesian Coordinates; ·········: Fixed Cartesian Coordinates.

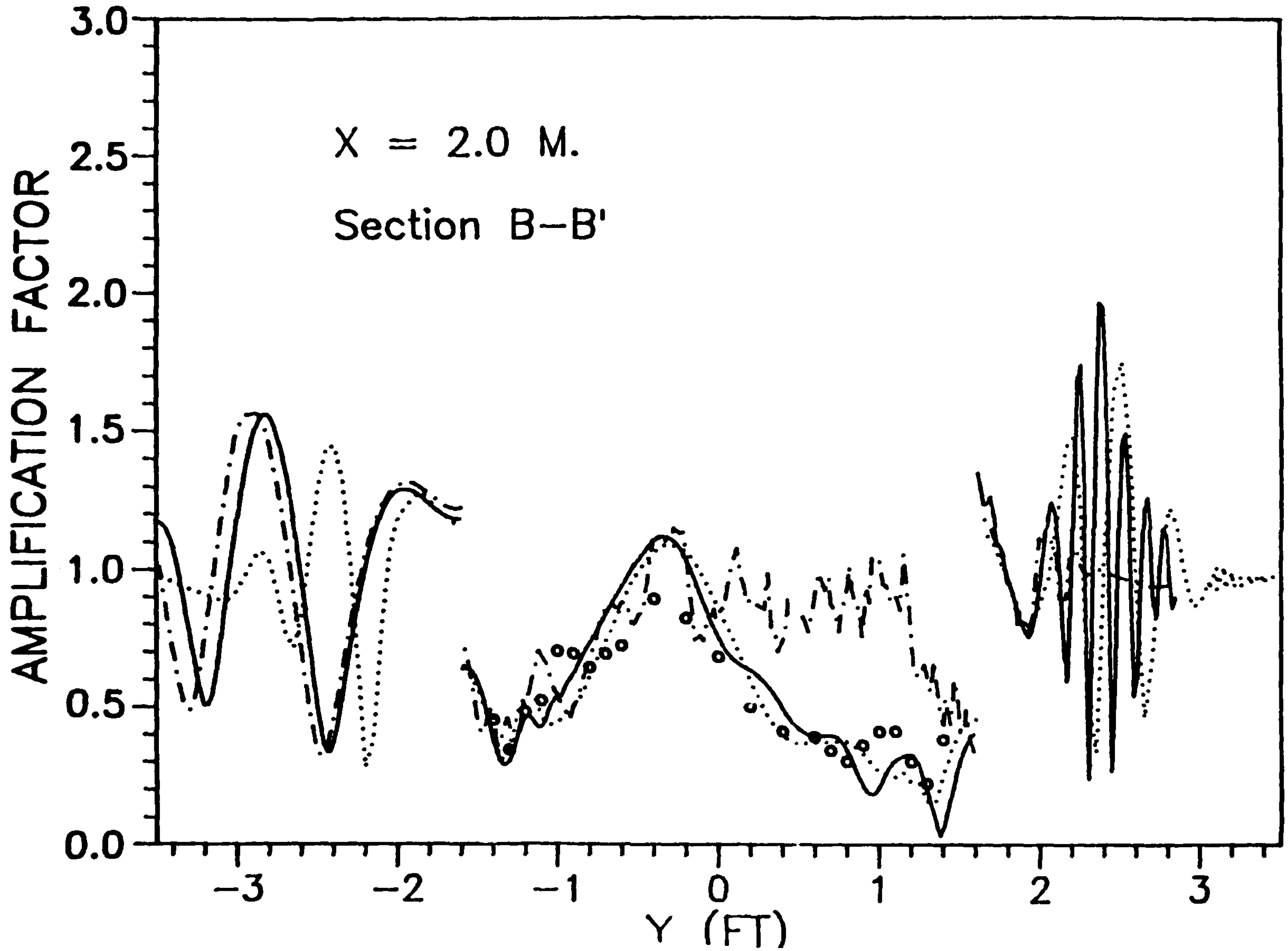


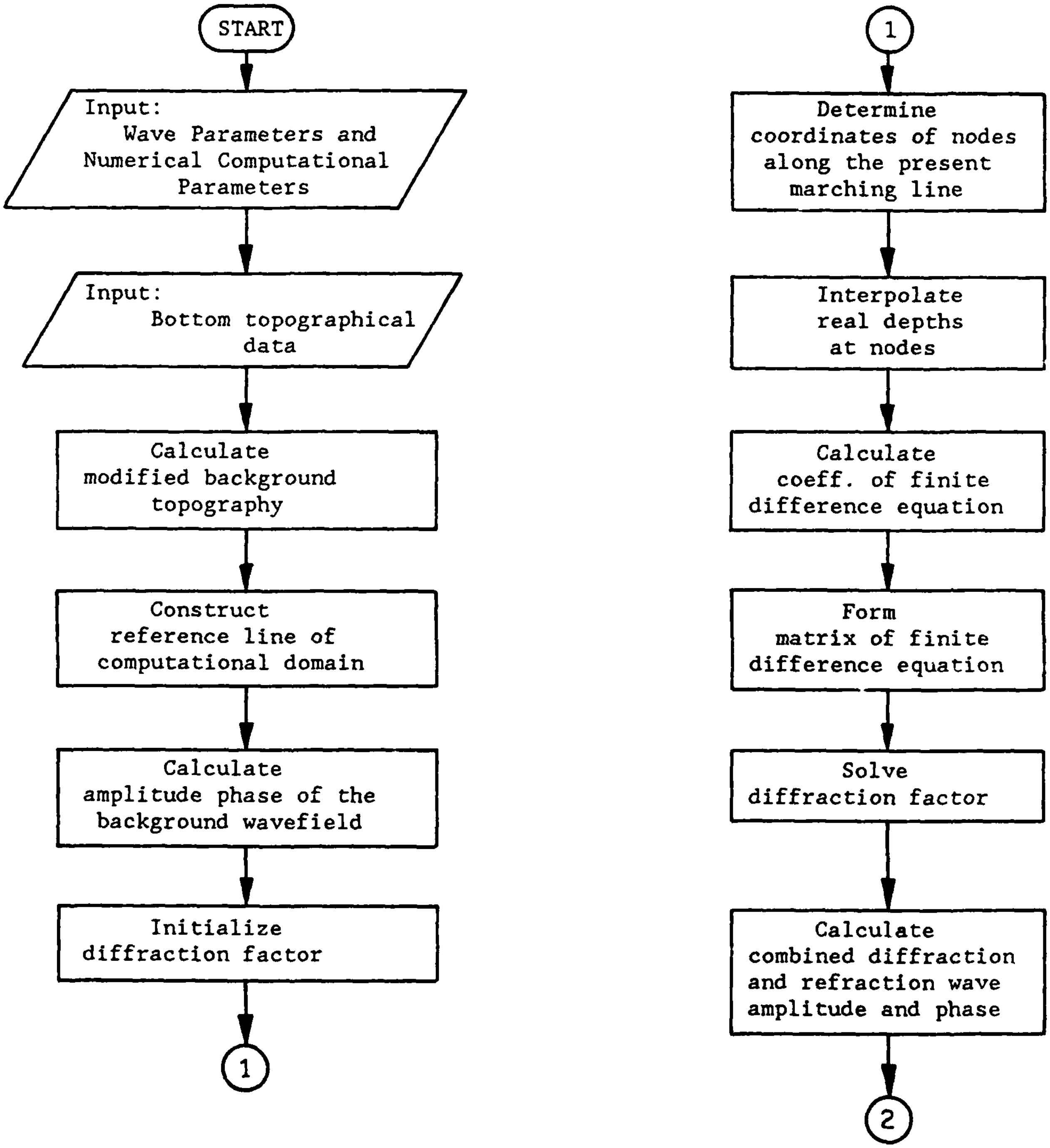
Figure 3.18b Comparison of Numerical Results with Experimental Measurement; o o o: Measurements, ——: Curvilinear Coordinates; —·—: Rotated Cartesian Coordinates; ········: Fixed Cartesian Coordinates.

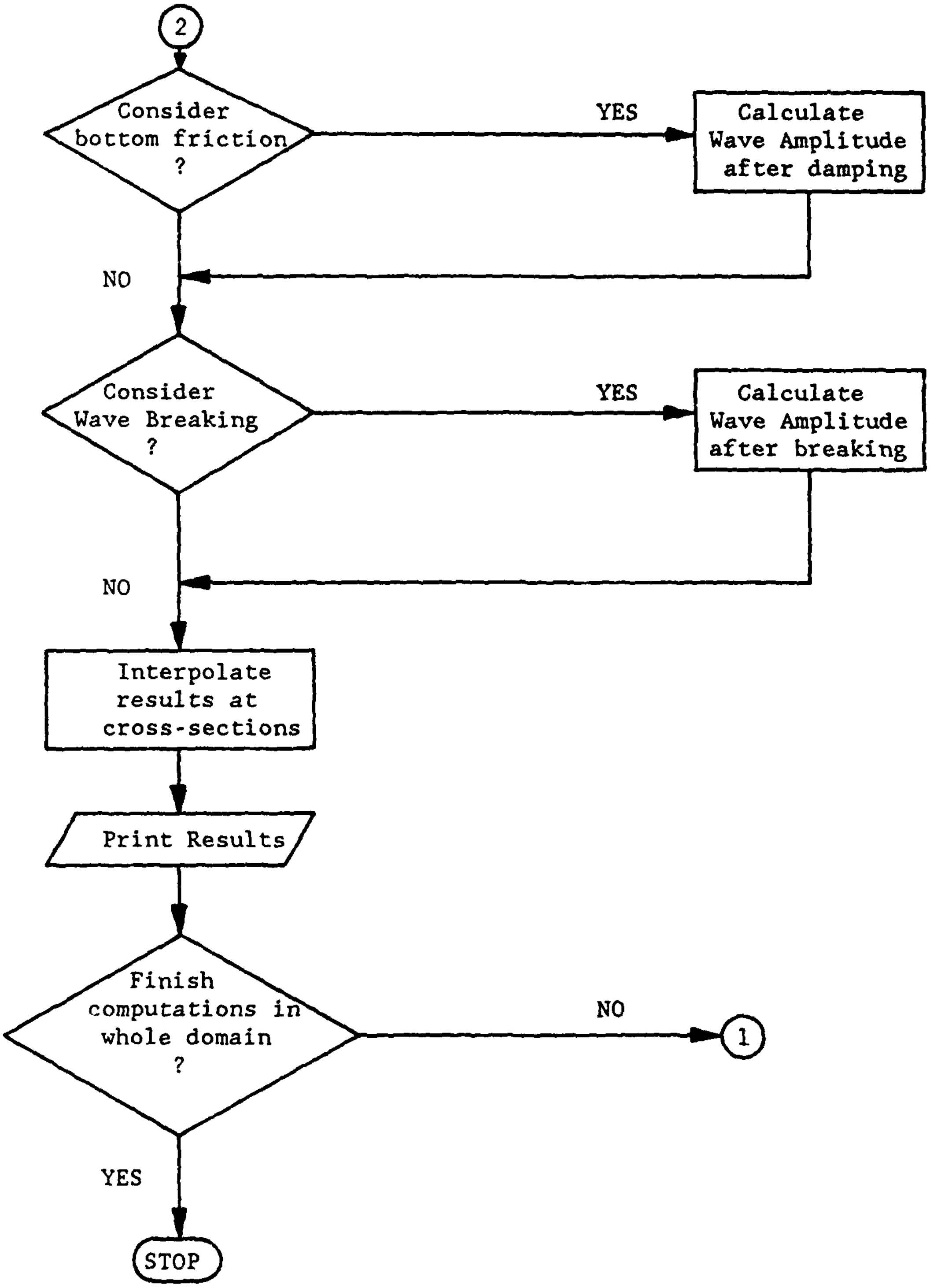
4. FLOW CHART, PROGRAM AND I/O DESCRIPTIONS

A computer program has been written using FORTRAN computer language to implement the computation of wave fields in an open coastal area. Because of the similarity of the governing equations using the three different coordinate systems, the program leaves the choice of the coordinates system to the user. The logic procedures involved in the computation are illustrated by the flow chart, Figure 4.1. The program has been written with a lot of self-explanatory comments for reference. Several possibilities in a particular step are also integrated to increase program flexibility, e.g. selection of bathymetric data interpolation methods etc. A brief discussion of the program will be given in this section. Detailed discussion of input and output data files of the program will follow.

4.1 Description of Input/Output Data (Files)

This program requires two to five input data files, depending on the mode of input and the problem being investigated. These are "IN.DAT", "LOC.DAT", "DEPTH.DAT", and/or "CURRNX.DAT", "CURRNY.DAT". The file "IN.DAT" is needed in batch and semi-interactive mode only while files of "CURRNX.DAT" and "CURRNY.DAT" are only required when a current field is presented in the problem. The program can operate in one of these options, namely, batch, semi-interactive, and interactive mode. If the interactive mode is selected to run the program the first time, the input data will be stored automatically in the file "IN.DAT" for future runs. Output from the program consists of from 1 to 10 separate files, with each separate file containing the results of one particular output profile. The file for profile 1 is called "OUT01.DAT", that for profile 2 is "OUT02.DAT", and that for profile 10 is "OUT10.DAT"


START
Input:
Wave Parameters and
Numerical Computational
Parameters
Input:
Bottom topographical
data
Calculate
modified background
topography
Construct
reference line of
computational domain
Calculate
amplitude phase of the
background wavefield
Initialize
diffraction factor
1
1
Determine
coordinates of nodes
along the present
marching line
Interpolate
real depths
at nodes
Calculate
coeff. of finite
difference equation
Form
matrix of finite
difference equation
Solve
diffraction factor
Calculate
combined diffraction
and refraction wave
amplitude and phase
2


2
Consider bottom friction ?
YES
Calculate Wave Amplitude after damping
NO
Consider Wave Breaking ?
YES
Calculate Wave Amplitude after breaking
NO
Interpolate results at cross-sections
Print Results
Finish computations in whole domain ?
NO
1
YES
STOP

This section contains the following files:

a) Input Files
   i) IN.DAT (batch and semi-interactive modes only)
   ii) LOC.DAT
   iii) DEPTH.DAT
   iv) CURRNX.DAT, CURRNY.DAT (presence of current only)

b) Output Files
   OUT01.DAT through OUT10.DAT

a) Input Files

i) IN.DAT

This file is not needed only when the user chooses the interactive mode (i.e. IBATCH = 0). This file is arranged in the following sequence of variables (free format): (Definitions of the variable names are discussed in section 4.2).

```
IOPTCO

IOPTBU, IOPTBD

AO, T, ALPHAD, G, TIDE

MXGRID, NYGRID

XO, YO, DSIG, DRHO, N, M, S1, S2, DC, DBASE

IP
IBACKD

IREALD

IDEPM, IPLINE

IFRCT, XDAMP, FRCT

IBREAK

ICURRN

IBKWTR

IBKWPT(1) (XBW(1, L), YBW (1, L), L = 1, IBKWPT(1))

IBKWPT(2) (XBW(2, L), YBW (2, L), L = 1, IBKWPT(2))

.
.          (IBKWTR-TH BREAKWATER)

TITLE (80 CHARACTERS MAX.)

NUMSEC
```

X1, Y1, X2, Y2 (1^{st} section)

X1, Y1, X2, Y2 (2^{nd} section)

.

.

. (NUMSEC-th section)

The program expects to read "NUMSEC" sets of two endpoints each. If IBKWTR is 0, the information on the breakwater can be skipped.

ii) File LOC.DAT

This file defines the locations of the "rows" and "columns" of the input depth grids. The "rows" are lines of constant x values and the "columns" are lines of constant y values. This file has two parts; first a listing of the x values of the rows (there should be MXGRID rows), and secondly a listing of the y values of the NYGRID columns. There are two possible forms for each of these parts, let's call them the sequential organization (usually for irregular grids) and the compact organization (always for a regular grid). Shown below is the file LOC.DAT for the topography at the CERC field station followed by a description of each input:

```
1
0.0      650.0      50.0

1
-500.0      500.0      50.0
```

This file in interpreted as follows:

---On the first line this integer input is the variable "IFORMX". IFORMX=1 indicates that the x-locations which follow will have the "compact" organization. IFORMX = 0 would indicate that the sequential organization will be used.

---On the second line, it indicates that the x-values will vary from x = 0 to x = 650 with a step size of 50.

---On the third line, the integer input is the variable "IFORMY", which is the same as "IFORMX" except that it refers to the organization of the y-values which are to follow.

---On the fourth line, it indicates that the y-values will range from y = -500. to Y = 500. with a step size of 50.

When an irregularly spaced grid is desired the sequential organization must be used. The following file is for the test discussed in section 3.2 for an elliptical shoal. The rest of the topography consists of a plane beach and therefore one would expect that the node spacing over the shoal should be more dense than that used over the plane beach.

```
 0
 0.      1.      5.      10.     13.      13.67     14.17     14.67
15.17   15.67   16.17   16.67   17.17     17.67     18.17     18.67
19.17   19.67   22.5    25.     30.
 0
-15     -10     -4      -3.5    -3        -2.5      -2        -1.5
 -1      -0.5    0       0.5     1         1.5       2         2.5
  3       3.5    4      10      15
```

This file is interpreted as follows:

```
 0
```

---This is IFORMX. Since it equals 0 the x-locations will follow in sequential order.

```
 0.      1.      5.      10.     13.      13.67     14.17     14.67
15.17   15.67   16.17   16.67   17.17     17.67     18.17     18.67
19.17   19.67   22.5    25.     30.
```

---These are the MXGRID separate values of the x-locations.

```
 0
```

---This is "IFORMY". IFORMY = 0 indicates that the y-values which follow

will have a sequential organization.

```
 -15     -10    -4    -3.5    -3    -2.5    -2    -1.5
  -1     -0.5    0     0.5     1     1.5     2     2.5
   3      3.5    4    10      15
```

---These are the NYGRID separate values of the y-locations.

Note: IFORMX and IFORMY do not have to have the same value.

iii) File DEPTH.DAT

This file contains the depths at the nodes which are located by the values read from file "LOC.DAT". There are three ways to input depth data, which are distinguished by "IFLIP". When IFLIP = 0, DEPTH.DATA is prepared along a row (constant x) in a sequence from left to right (facing land). The order of row is from minimal x to maximal x. When IFLIP = 1, "DEPTH.DAT" is prepared along a row (constant x) in a sequence from right to left. The order of rows is the same as that of IFLIP = 0. When IFLIP = 2, DEPTH.DAT is prepared along a column (constant y) from land to sea. The order of column is from left (min. y) to right (max. y). A small part of two separate depth input files are shown below.

```
  1
 -0.3   .2   .6   .3   -.1   -.4   -.5   -.4   -.2   .2
  0.6   .8  1.0  1.2   1.0    .9   1.0    .9    .6   .4
  0.2  0.0  -.1  -.3   -.9  -1.0  -0.8  -0.2    .4 -0.2
 -0.4 -0.3   .1   .7    .7   1.2   2.0   1.2    .8   .9
  1.4  2.5  3.9  2.4   1.3    .7    .5    .4    .3  0.0
   .5   .8   .9   .9    .7    .6    .5    .6    .8  1.0
  1.0  1.5  1.7  1.6   1.9   1.9   1.6   1.6   1.3   .9
  1.0   .9   .4   .2    .3    .1    .2    .4    .9   .8
   .9  1.1  1.5  1.9   2.1   2.3   2.6   2.3   2.1  2.3
   .
   .
   .
   .
 11.4 11.4 11.5 11.7  11.6  11.7  11.7  11.6  11.8 11.8
 11.7 11.8 11.8 11.8  11.7  11.6  11.6  11.6  11.6 11.7
 11.8 11.9 12.0 12.0  12.1  12.1  12.2  12.2  12.3 12.3
```

The user should note that on the first line a single integer value is read. This integer is the value of "IFLIP" (see subroutine MAKEC) which will always have a value of either 0, 1 or 2. In order to understand the meaning of "IFLIP" consider the following situation: you are on a straight beach facing land directly from sea (say that you are facing north), if IFLIP = 0 the depths in each row will be read starting at your left and will proceed to your right (the depths will be read from west to east). On the otherhand, if IFLIP = 1 then each row will be "flipped" and the depths will be read from right to left (east to west).

Following is part of the depth input file for the elliptical shoal test, which since it is totally symmetrical could use IFLIP = 0 or 1.

```
0
0.      0.       .  .  .     0.     0.     0.
0.      0.       .  .  .     0.     0.     0.
0.
.02     .02      .  .  .     .02    .02    .02
.02     .02      .  .  .     .02    .02    .02
.02
.  .    .        .  .  .     .   .   .   .   .
0.45    0.45     .  .  .        .45    .45    .45
```

Note: negative depths are simply elevations above sea level.

iv) Files CURRNX.DAT and CURRNY.DAT

When a current field is to be considered in the problem, the structures of files of CURRNX.DAT and CURRNY.DAT must be exactly the same as that of the file DEPTH.DAT except the flag of IFLIP is not needed. That means the depth and current components are input at the same locations. In the case of no current, these two files are not required.

b) Output files

OUT01.DAT ... OUT06.DAT ... OUT10.DAT

These files each correspond to an individually defined output profile and contain data on the intersection of that profile with the computational line at each marched step of the calculation.

4.2 DESCRIPTION OF SUBROUTINE AND DEFINITION OF VARIABLES

THESE SUBROUTINES HAVE BEEN GROUPED UNDER ONE OF THREE MAIN HEADINGS, THESE ARE:

a) FLOW OF CONTROL AND MISCELLANEOUS AUXILLIARYS
b) DEPTH AND/OR CURRENT INTERPOLATION
c) GENERAL EQUATION SOLVERS

```
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C   a) MAIN PROGRAM / FLOW OF CONTROL + VARIOUS AUXILLIARY ROUTINES
C
C
C    THE PRESENT CAPACITY OF THE PROGRAM IS LIMITED TO 500 NODES ON A
C  COMPUTATION LINE.  CERTAIN RELATIONSHIPS BETWEEN N AND M MUST BE
C  MAINTAINED
C      1) N+M .LE. 2000;     2) N .LE. 500
C  IF IT IS DESIRED TO EXPAND THE DIMENSION OF THE ARRAYS THEN THESE
C  RELATIONSHIPS MUST ALSO BE MODIFIED.  FOR EXAMPLE IF THE ARRAYS ARE
C  DIMENSIONED TO 600 THEN EITHER  M.LE.1400  OR THE LARGE ARRAYS MUST
C  ALSO BE EXPANDED. ALSO, WHEN USING CURVILINEAR COORDINATES DELTA
C  SIGMA (STEP IN DIRECTION OF PROPAGATION) MUST BE AN INTEGER MULTIPLE
C  OF DELTA RHO (STEP ALONG TRANSVERSE DIRECTION) ie: DSIG=15 AND
C  DRHO=10 IS NOT ALLOWABLE.
C    THE MAJORITY OF COMUNICATION OF DATA BETWEEN THE MAIN PROGRAM AND
C  THE SUBROUTINES IS ACCOMPLISHED THROUGH THE USE OF SEVERAL LABELED
C  COMMON STATEMENTS.  THESE WILL BE REFERRED TO AS A GROUP AS THE
C  "COMMON BLOCK".
C   THE FUNCTION OF THE MAIN PROGRAM IS TO CONTROL THE READING
C  OF INPUT FROM THE INPUT FILES AND THE KEYBOARD.
C
C      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
C      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
C      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
C      COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      COMMON/AG/XI,YI,DEP,U,V
C      COMMON/AH/NUMSET,IUNIT,X11,Y11,X21,Y21,TITLE
C      COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
C      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C      DIMENSION IUNIT(10),X11(10),Y11(10),X21(10),Y21(10)
C      DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10)
C      CHARACTER*80 TITLE
C
C THE UNIT DESIGNATIONS ARE AS FOLLOWS:
C         5 = KEYBOARD
C         6 = SCREEN
C         9 = INPUT FILE CONTAINING THE DEPTHS
C        10 = INPUT FILE CONTAINING GRID COORD.
C        11 = INPUT FILE CONTAINING X-COMP. OF CURRENT
C        12 = INPUT FILE CONTAINING Y-COMP. OF CURRENT
C FILES OF UNITS 11 AND 12 ARE NEEDED WHEN ICURRN = 1
C        13 = INPUT FILE (MISCELLANEOUS INFO)
C        21-30 = OUTPUT FILES CONTAINING LOCATIONS, AMPLITUDE, AND PHASE
C             DATA FOR EACH PROFILE.
C
```

```
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C   DEFINITION OF VARIABLE NAMES:
C
C    IBATCH= 0: INTERACTIVE; ALL DATA INPUT FROM KEYBOARD EXCEPT DEPTH.DAT,
C             LOC.DAT, AND/OR CURRNX.DAT AND CURRNY.DAT. YOU CAN ALSO ADJUST
C             PARAMETERS
C            1: SEMI-INTERACTIVE; NO DATA INPUT FROM KEYBOARD, BUT AT
C               SEVERAL BREAKPOINTS PROGRAM ALLOWS YOU TO ADJUST PARAMETERS
C            2: BATCH MODE; AFTER RESPOND TO SYSTEM'S REQUEST OF IBATCH
C               YOU CAN NOT ALTER ANY PARAMETERS
C    IOPTCO= 0: CURVILINEAR COORDINATES
C            1: CARTESIAN COORDINATES (ROTATED IN PROPAGATION DIRECTION)
C            2: CARTESIAN COORDINATES (FIXED)
C    IOPTBU,IOPTBD= UPWAVE AND DOWNWAVE LATERAL BOUNDARY CONDITION
C            0: OPEN BOUNDARY CONDITIONS
C            1: SOLID BOUNDARY CONDITIONS
C    A0= INITIAL WAVE AMPLITUDE (UNIT MUST BE CONSISTENT WITH G)
C    T= THIS IS THE WAVE PERIOD (UNIT MUST BE CONSISTENT WITH G)
C    ALPHAD (IN DEGREE)= INITIAL ANGLE OF INCIDENCE (CONVERTED INTERNALLY
C            TO RADIANS).  NOTE: STANDING ON SHORE AND FACING SEAWARD, ALPHA
C            IS NEGATIVE FOR ANGLE IS COUNTER-CLOCKWISE FROM 12 O'CLOCK
C            POSITION AND POSITIVE FOR CLOCKWISE
C    TIDE=TIDE LEVEL REFERRED TO MEAN SEA WATER LEVEL
C    G= ACCELERATION DUE TO GRAVITY
C    MXGRID= NUMBER OF ROWS (X=CONSTANT) OF DEPTH DATA WHICH ARE TO BE INPUT
C    NYGRID= NUMBER OF COLUMNS (Y=CONSTANT) OF DEPTH DATA WHICH ARE TO BE
C            INPUT
C    X0,Y0= REFERENCE POINT OF REFERENCE LINE (CHOOSE POINT AT THE UPWAVE
C            SIDE OF INTERESTED AREA)
C    DSIG= DELTA SIGMA = GRID SIZE IN THE DIRECTION OF MARCHING
C    DRHO= DELTA RHO = GRID SIZE PARALLEL TO TRANSVERSE LINE
C    N= THE NUMBER OF NODES ALONG THE TRANSVERSE LINE. (NOTE: N HAS
C            INTERMEDIATE VALUES BEFORE THE ABOVE DESCRIPTION IS CORRECT)
C    M= MAX. NUMBER OF MARCHING STEPS IN PROPAGATION
C    S1,S2= BOTTOM SLOPE AT FIRST ROW OF INPUT DEPTHS (NEAR SHORE) AND LAST
C            ROW (DEEP WATER)-USED ONLY FOR CUBIC SPLINE OF BACKGROUND DEPTH
C    DC= DEPTH AT CONSTANT DEPTH REGION (DEEP WATER)
C    DBASE= DEPTH AT BASELINE
C    U,V= X,Y-COMPONENT OF CURRENT
C    IP=NUMBER OF MARCHED STEPS TO SKIP BETWEEN INTERPOLATIONS
C    IFRCT,XDAMP=FLAG FOR BOTTOM FRICTION AND LOCATION AT WHICH BOTTOM
C            FRICTION EFFECTS START TO BE CALCULATED
C    FRCT= BOTTOM FRICTION FACTOR
C    TITLE = TITLE OF THE OUTPUT FILE (LESS THAN 80 CHARACTERS)
C    NTRUC= NUMBER OF NODES ON TRUNCATED PHASE LINE
C    IDEPM,IPLINE= PRINTING FLAGS (1: PRINT ON SCREEN; 0:NO PRINT-OUT)
C    IBACKD (BACKGROUND DEPTH SCHEME)
C        =0 :PLANE BEACH WITH SLOPE =0.01 (USED FOR DEBUGGING)
C        =1 :CUBIC SPLINE OVER AVG. DEPTH AT EACH ROW'
C        =2 :LEAST SQUARE CUBIC EQN. IN X-DIRECTION.
C    IREALD (ACTUAL DEPTH)
C        =0 :PLANE BEACH WITH SLOPE=0.01  (USED FOR DEBUGGING)
C        =1 :LINEAR AVG. OF 4 SURROUNDING GRID POINTS
C        =2 :USES A 16 POINT GRID FOR A CUBIC SPLINE ACROSS EACH OF FOUR
C            ROWS AND THEN ONCE DOWN THE INTERPOLATED ALONG THE DESIRED
C            Y-VALUE
C        =3 :LIKE IREALD=2 EXCEPT THE SPLINE IS DONE ON THE COLUMNS AND
C            THEN THE ROW OF THE DESIRED X-VALUE
C        =4 :LEAST SQUARE FIT OF 16-POINT GRIDS TO A 6 COEFF. DEPTH
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C           EXPRESSION
C    BETA= K*SIN(ALPHA)
C    OMEGA= ANGULAR FREQUENCY OF INCIDENT WAVE.
C    IBKWTR=FLAG OF PRESENCE OF BREAKWATER
C         0 : NO BREAKWATER AT ALL
C         # : NO. OF BREAKWATERS WILL BE ENCOUNTERED DURING COMPUTATION
C            (LIMITED TO 5)
C    IBKWPT(I)= NO. OF POINTS TO DESCRIBE LINEAR SEGMENTS OF I-TH
C            BREAKWATER (2 TO 10, IF ANY)
C    XBW(I,J),YBW(I,J)=COORDINATES OF J-TH POINT ON I-TH BREAKWATER
C    ICURRN=FLAG OF CURRENT FIELD
C         1 : EFFECTS OF CURRENT FIELD ON WAVE CONSIDERED
C         0 : NO CURRENT EFFECTS
C    C(4,MX)= ARRAY OF COEFFICIENTS USED IN A CUBIC SPLINE INTERPOLATION.
C             Ex. F(x)= C(1,I)+C(2,I)x+C(3,I)x*x+C(4,I)x*x*x.
C    IBREAK = 0  FOR NO WAVE BREAKING; = 1 FOR BREAKING
C    NUMSEC = NO. OF SECTIONS ALONG WHICH WAVE FIELD WILL BE SHOWN IN THE
C             OUTPUT FILE (< OR = 10) UNDER FILENAMES AS OUT01.DAT;
C             OUT02.DAT;....;OUT10.DAT
C    IUNIT = UNITS FOR OUTPUT FILES
C    X11,Y11 = STARTING POINT OF SECTIONS
C    X21,Y21 = ENDING POINT OF SECTIONS
C    NN=MAX POSSIBLE NUMBER OF NODES TO LANDWARD
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C       SUBROUTINE MAKEPL
C
C    THIS SUBROUTINE (MAKE computational PLane) ALLOWS FOR THE SELECTION
C  OF THE DESIRED DEPTH INTERPOLATION SCHEME. THIS SUBROUTINE FORMS THE
C  DIFFERENCE EQUATIONS TO BE SOLVED, CALLS THE SOLVING SUBROUTINES, AND
C  CALLS THE OUTPUT ROUTINES AT DESIRED MARCHING STEP.
C
C  SOME INTERNAL VARIABLES:
C  N  = 'THE NUMBER OF REFERENCE POINTS IN SEAWARD DIRECTION'
C     = THE MAXIMUM NUMBER OF NODES ADDED ON THE SEAWARD SIDE OF THE
C       REFERENCE POINT ALONG THE TRANSVERSE LINE.
C  XLB = FARTHEST EXTENT OF NEAR FIELD IN X-DIRECTION (I.E. MAX. X)
C  IDIRC= FLAG FOR DIRECTION OF INCIDENT WAVES; IDIRC=1 FOR POSITIVE
C       INCIDENT ANGLE; IDIRC=-1 FOR NEGATIVE INCIDENT ANGLE.
C  RECALL: M IS THE MAX. NUMBER OF NODES IN LANDWARD DIRECTION
C  FO,FN = OLD AND NEW ARRAY OF DIFFRACTION FACTOR
C  A1,A2,A3 = ARRARY OF A IN MATRIX EQUATION A*X=B
C  B = FORCING TERM IN MATRIX EQUATION A*X=B
C  AMPRD = PRODUCT OF AMPLT * DIFFRACTION FACTOR
C  AMPLT = LOCAL AMPLT DUE TO REFRACTION AND SHOALING ONLY
C  PHASE = LOCAL PHASE DUE TO REFRACTION AND SHOALING ONLY
C  PHASEL = PHASE OF POINTS ALONG REFERRENCE LINE
C  XX,YY = X- AND Y- COORDINATES ALONG REFERENCE LINE
C  ARO,ARN = OLD AND NEW CALCULATED AMPLITUDE
C  ASO,ASN = OLD AND NEW CALCULATED PHASE
C  XG,YG = INTERMIDIATE COORDINATES OF POINTS IN MARCHING
C  XOLD,YOLD,XNEW,YNEW = OLD AND NEW COORDINATES IN EACH MARCHING STEP
C  XI,YI = ARRARY IN X- AND Y- DIRECTIONS AT THE GRIDS WHERE REAL DEPTH
C       AND/OR CURRENT DATA WILL BE INPUT
C  DEP = DEPTH AT INTERSECTIONS OF XI AND YI
C  U,V = X,Y-COMPONENT OF CURRENT
C  TITLE = TITLE TO IDENTIFY OUTPUT FILE OF THE RESULTS
C  NUW(I) = NUMBER OF POINTS ON THE UPWAVE SIDE AT PRESENT COMPUTING
C      AT I-TH BREAKWATER
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C  NUW1(I) = NUMBER OF POINTS ON THE UPWAVE SIDE AT PREVIOUS COMPUTING
C       AT I-TH BREAKWATER
C  IDM = 0 :BREAKWATER HAS NOT BEEN ENCOUNTERED
C       IF GREATER THAN 0 : (IDM) BREAKWATERS HAVE BEEN ENCOUNTERED
C  IBK(I) = FLAG FOR I-TH BRKWTR, 1: ENCOUNTERED; 0: NOT YET
C  IDN = FLAG OF ENCOUNTERING OF BREAKWATER BETWEEN ANY TWO POINTS
C       ON A COMPUTATIONAL LINE
C       = 0 NO PRESENCE OF BREAKWATER
C       = 1 A BREAKWATER IS ENCOUNTERED
C        WKT IS ACTUAL WAVENUMBER, THEREFORE BELOW IS -V0.
C  V1 = TERMS OF EFFECTS OF CURRENT ON WAVES
C  V2 = TERM OF ENERGY DISSIPATION DUE TO BREAKING
C  V3 = TERM OF ENERGY DISSIPATION DUE TO BOTTOM FRICTION
C  US = TERM OF CURRENT EFFECTS ON WAVE NO. IN MARCHING DIRECTION
C  UN = TERM OF CURRENT EFFECTS ON WAVE NO. IN TRANSVERSE DIRECTION
C  DIVU = DIVERGENCE OF CURRENT VELOCITY
C  WK2U+WK2V =INNER PRODUCT OF WK HAT AND CURRENT
C
C       COMPLEX FO(500),FN(500),C1,C3,C4,A1(500),A2(500),DTHE
C       COMPLEX AMPRD(500),A3(500),B(500),CB,VV,V1,V2,V3
C       COMPLEX C5(5),C6(5),C7(5),C8(5),C9(5),C10(5),C11(5),C12(5)
C       COMPLEX C50(5),C60(5),C70(5),C80(5),C90(5),C100(5),C110(5),C120(5)
C       COMPLEX CD1,CD2,CD3,CD4
C       COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
C       COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
C       COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
C       COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
C       COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C       COMMON/AG/XI,YI,DEP,U,V
C       COMMON/AH/NUMSEC,IUNIT,X11,Y11,X21,Y21,TITLE
C       COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
C       COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C       COMMON/CC/ C
C       DIMENSION ARO(500),ARN(500),ASN(500),ASO(500),IBROKN(500)
C       DIMENSION XX(2000),XG(500),YY(2000),YG(500),PHASEL(2000)
C       DIMENSION CG(2000),WKN(2000),DEPM(2000),THETA(2000),AMPM(2000)
C       DIMENSION XOLD(500),YOLD(500),XNEW(500),YNEW(500)
C       DIMENSION AMPLT(500),PHASE(500),WKFS(500),DNODE(500)
C       DIMENSION C(4,134),XI(134),YI(133),DEP(134,133),U(134,133)
C       DIMENSION IUNIT(10),X11(10),Y11(10),X21(10),Y21(10),V(134,133)
C       DIMENSION AM2(500),AM1(500),PGC1(500),PGC0(500),PGC(2000)
C       DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10),NUW(5),NUW1(5),IBK(5)
C       CHARACTER*80 TITLE
C       CHARACTER*9 OUTFIL(10)
C       DATA OUTFIL/'OUT01.DAT','OUT02.DAT','OUT03.DAT','OUT04.DAT',
C      & 'OUT05.DAT','OUT06.DAT','OUT07.DAT','OUT08.DAT','OUT09.DAT',
C      & 'OUT10.DAT'/
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C       SUBROUTINE REVIEW
C
C    THIS SUBROUTINE ALLOWS THE USER TO INTERACTIVELY CHECK AND CHANGE
C  THE VALUES OF PARAMETERS DEFINED ELSEWHERE, GENERALLY AS INPUT.
C
C       COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
C       COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
C       COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
C       COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
C       COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
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C       COMMON/AG/XI,YI,DEP,U,V
C       COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
C       COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C       DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10)
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE CHECK(X)
C
C    SUBROUTINE TO ALLOW THE USER TO INTERACTIVELY CHANGE THE VALUE
C  OF A REAL PARAMETER (TRIBUTARY TO ROUTINE REVIEW).
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE ICHECK(J)
C
C    SUBROUTINE TO ALLOW THE USER TO INTERACTIVELY CHANGE THE VALUE
C  OF AN INTEGER PARAMETER  (TRIBUTARY TO ROUTINE REVIEW).
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE SIDEVW(NUM,X1,Y1,X2,Y2,IFIXIT)
C
C  SKETCH THE BOTTOM TOPOGRAPHY BENEATH SOME PROFILE OF INTEREST
C
C      SUBROUTINE SIDEVW(NUM,X1,Y1,X2,Y2)
C
C   INPUT: NUM,X1,Y1,X2,Y2;  RETURNED: IFIXIT
C
C  DEFINITION OF VARIABLES:
C      NUM= NUMBER OF PROFILES SPECIFIED FOR OUTPUT.
C      X1,Y1,X2,Y2= ARRAYS WHICH STORE THE LOCATIONS OF THE END
C          POINTS OF THE PROFILES TO BE USED AS OUTPUT PROFILES.
C      IFIXIT= A FLAG VARIABLE TO CHANGE THE SPECIFICATION OF
C          ONE OR MORE OUTPUT PROFILES.
C           =0: NO CHANGE.
C           =1: CHANGE SPECIFICATION OF SOME PROFILES.
C
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      COMMON/AG/XI,YI,DEP,U,V
C      DIMENSION X1(10),Y1(10),X2(10),Y2(10)
C      DIMENSION XI(134),YI(133),DEP(134,133),U(134,133),V(134,133)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C     SUBROUTINE CURVIL(BETA,WK,THE,DG,DX,DY,IOPTCO)
C
C     THIS SUBROUTINE TRANSFORMS A KNOWN STEP IN CURVILINEAR COORDINATES
C   INTO A CORRESPONDING STEP IN PHYSICAL COORDINATES. IT ONLY DETERMINES
C   LOCAL INCIDENT ANGLE IN ALL CARTESIAN COORDINATES OPTIONS.
C
C    INPUT: BETA,ALPHA,WK,DG;    RETURNED: THE,DX,DY
C
C  DEFINITION OF VARIABLES:
C       BETA = K SIN(ALPHA) (SEE EQN 16 IN JGR ARTICLE)
C       ALPHA = DEEP WATER INCIDENT ANGLE
C       WK= WAVE NUMBER (BACKGROUND WAVE FIELD)
C       DG= CURVILINEAR STEP SIZE ALONG WAVE CREST
C       THE= THE ANGLE OF INCIDENCE AT THE NEW LOCATION
C       DX= STEP SIZE IN X-DIRECTION
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C       DY= STEP SIZE IN Y-DIRECTION
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE WAVENO(D,WK,GC,PGC,IDEPTH)
C
C  SOLVES THE DISPERSION RELATION BY NEWTON-RAPHSON METHOD.
C
C  INPUT: OMEGA,G,D;    RETURNED: WK,GC,PGC,IDEPTH
C
C  DEFINITION OF VARIALBES:
C        OMEGA= WAVE FREQUENCY
C        G= GRAVITY
C        D= DEPTH
C        WK= WAVE NUMBER
C        GC= GROUP VELOCITY
C        PGC=PC*GC (PC= PHASE VELOCITY)
C        IDEPTH= -1: SHALLOW WATER; = 1: INTERMEDIATE OR DEEP WATER
C
C      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE BDYGRD(XG,YG,THETA,MX,XI,C,XLB,IOPTCO,COSINE,SINE)
C
C    THIS  SUBROUTINE (BounDarY GRiD) DETERMINES THE BOUNDARY OF
C  COMPUTATIONAL REGION ON GRID MESH FOR DIFFERENT COORDINATE SYSTEMS.
C
C   INPUT: XG, YG, THETA, MX, XI, C, XLB, IOPTCO, COSINE, SINE
C   RETURNED: XG(1),  YG(1)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE CROSS(PX1,PY1,PX2,PY2,X1,Y1,X2,Y2,INTCON,XINT,YINT)
C
C  SUBROUTINE FOR PROFILE INTERSECTION WITH LINE SEGMENT.
C
C   INPUT: PX1,PY1,PX2,PY2,X1,Y1,X2,Y2;    RETURNED: INTCON,XINT,YINT
C
C  DEFINITION OF VARIABLES:
C     (PX1,PY1)=FIRST END-POINT DEFINING PROFILE
C     (PX2,PY2)=SECOND END-POINT DEFINING PROFILE
C     (X1,Y1)= FIRST ENDPOINT DEFINING SEGMENT
C     (X2,Y2)= SECOND ENDPOINT DEFINING SEGMENT
C     INTCON="INTERSECTION CONDITION" : =0 FOR NO CROSSING WITHIN SEGMENT;
C          =1 FOR CROSSING AT ONE POINT ON SEGMENT; =2 FOR PARALLEL LINES,
C          ie. CROSSING ON WHOLE LENGTH OF SEGMENT.
C     XINT,YINT=INTERSECTION OF THESE TWO LINES
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE CRSOUT(X,Y,A,S,IUNIT)
C
C  SUBROUTINE TO OUTPUT CROSSING DATA (TRIBUTARY TO SUBROUTINE INTRSC)
C
C    INPUT:  X,Y,A,S,IUNIT
C    RETURNED: WRITE THE OUTPUT ON THE SPECIFIED (IUNIT) FILE
C
C      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
C
```

```
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE INTRSC(N,XBASE,XN,YN,XOLD,YOLD,X1,Y1,X2,Y2,
C     *  AMPLT,AMPOLD,PHASE,PHOLD,IUNIT)
C
C     SUBROUTINE TO FIND INTERPOLATED VALUES FOR PHASE AND AMPLITUDE ALONG
C   SPECIFIED CROSS-SECTIONS.  THE INTERPOLATION IS LINEAR BETWEEN THE
C   UNEVENLY SPACED POINTS.  AT EACH CALL TO THIS SUBROUTINE THE ENTIRE
C   COMPUTATIONAL LINE IS CHECKED AGAINST EACH PROFILE.
C
C   INPUT: N,XBASE,XN,YN,XOLD,YOLD,X1,Y1,X2,Y2,AMPLT,AMPOLD,PHASE,PHOLD,
C          IUNIT
C   OUTPUT: CALL SUBROUTINE CRSOUT
C
C   DEFINITION OF VARIABLES:
C    N= NUMBER OF NODES PRESENTLY ON COMPUTATIONAL LINE
C    XBASE= X-COORDINATE OF BASE LINE (XUB)
C    XN,YN= ARRAYS WHICH STORE THE X AND Y LOCATIONS OF THE NODES ON THE
C           PRESENT COMPUTATIONAL LINE
C    XA,YA,XB,YB= THE TWO NODES ON THE COMPUTATIONAL LINE WHICH ARE BEING
C           CHECKED AT ANY GIVEN MARCHED STEP.
C    XOLD,YOLD= ARRAYS WHICH STORE THE X AND Y LOCATIONS OF THE NODES ON
C           THE COMPUTATIONAL LINE AT PREVIOUS STEP.
C    X1,Y1= STORE LOCATION OF THE FIRST POINT WHICH DEFINES THE PROFILE.
C    X2,Y2= STORE LOCATION OF THE SECOND ENDPOINT OF THE PROFILE.
C    AMPLT= AMPLITUDES AT THE NODES OF THE PRESENT COMPUTATIONAL LINE.
C    AMPOLD= AMPLITUDES AT THE NODES OF THE COMPUTATIONAL LINE AT THE
C           PREVIOUS STEP.
C    PHASE= VALUES OF THE PHASE ANGLE AT THE NODES OF PRESENT LINE
C    PHOLD= VALUES OF THE PHASE ANGLE AT THE NODES AT PREVIOUS STEP.
C    IUNIT= NUMBER OF THE LOGICAL UNIT TO WRITE THE RESULTS TO
C    NW= CURRENT NO. OF POINTS AT UPWAVE SIDE OF BREAKWATER
C    NW1= PREVIOUS NO. OF POINTS AT UPWAVE SIDE OF BREAKWATER
C
C       DIMENSION XN(N),YN(N),AMPLT(N),XOLD(N),YOLD(N),AMPOLD(N)
C       DIMENSION PHASE(N),PHOLD(N),NW(5),NW1(5)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C   b)  SUBROUTINES THAT DEAL WITH THE DEPTH INTERPOLATION SCHEMES
C       FOR BOTH THE BACKGROUND AND REAL TOPOGRAPHY.
C                 CALCCF
C                 CUBDEP
C                 CUSPIP
C                 DEPINP
C                 LSBFIT
C                 LSTSQR
C                 MAKEC
C                 MAKEQN
C                 MAKEQ2
C                 PCUBIC
C                 SPLINE
C                 SPL4PT
C                 TRALOC
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE CALCCF(N,MX,XI,C)
C
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```
C    THIS  SUBROUTINE CALCCF(CALculate Cubic spline CoEffients) IS PART OF
C  A THREE SUBROUTINE PACKAGE TO PERFORM THE CALCULATION OF A CUBIC SPLINE
C  (TRIBUTARY TO ROUTINE "CUSPIP").
C
C  INPUT: N,MX,XI;     RETURNED: C
C
C  NOTE:     N= NO. OF POINTS, N MUST BE .LT. MX
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE CUBDEP(IFLAG,DEPTH,XGRID,YGRID,X,Y,DR,DRDX)
C
C    THIS SUBROUTINE CONTROLS THE EXECUTION OF "REAL" DEPTH OPTIONS
C  IREALD(IFLAG)=2 AND 3 .  OPERATING ON A 16 NODE GRID, FOUR CUBIC
C  SPLINES ARE DONE IN ONE DIRECTION AND THEN ONE SPLINE IS DONE IN
C  THE PERPENDICULAR DIRECTION.
C    IF IREALD=2 CUBIC SPLINE ACROSS EACH X-ROW IS DONE FIRST. I.E.
C  SPLINE ACROSS ROWS TO INTERPLOATE QUANTITY AT THE INTERSECTION OF
C  EACH ROW WITH THE DESIRED Y AND THEN SPLINE DOWN THESE FOUR VALUES
C  TO YIELD AN INTERPOLATED QUANTITY AT X.
C    IF IREALD=3 CUBIC SPLINE IS DOWN ON EACH Y-COLUMN FIRST, THEN
C  ACROSS X-ROW.
C
C    INPUT: IFLAG,DEPTH,XGRID,YGRID,X,Y
C    OUTPUT: DR,DRDX
C
C   DEFINITION OF VARIABLES:
C      IFLAG= FLAG OF OPTIONS FOR INTERPOLATION
C      DEPTH= FUNCTION TO BE INTERPOLATED
C      XGRID,YGRID= GRIDS OF THE FUNCTION
C      X,Y= LOCATION OF INTEREST
C      DR= INTERPOLATED VALUEOF FUNCTION AT (X,Y)
C      DRDX= FIRST DERIVATIVE OF THE FUNCTION AT (X,Y) W.R.T. X OR Y
C
C      DIMENSION DEPTH(16),XGRID(4),YGRID(4),DINTRP(4)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE CUSPIP(MX,NY,X,Y,D,C,S1,S2,DBASE)
C
C  SUBROUTINE CUSPIP ( CUbic SPline InterPolation )
C     INPUT: MX,NY,X(just passed through),Y,D,S1,S2,DBASE
C     RETURNED: C
C
C  NOTE: THE ARRAY C CONTAINS THE COEFFICIENTS OF THE CUBIC EQUATION
C  USED IN A CUBIC SPLINE INTERPOLATION ALONG EACH ROW OF NODES. THIS
C  SUBROUTINE IS USED FOR "BACKGROUND" DEPTH INTERPOLATION OPTION 1.
C  A CUBIC SPLINE IS SET UP FOR THE AVERAGE DEPTH AT X-ROWS, AND THE
C  EQUATIONS ARE SOLVED BY CALLING SUBROUTINES "SPLINE" AND "CALCCF".
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE DEPINP(IX,IX1,IY,IY1,X,Y,DR,UX,VY,DIVU)
C
C    SUBROUTINE DEPINP (DEPth INterPolation) RETURNS A VALUE OF THE "REAL"
C  DEPTH,CURRENT COMPONENTS AND DIVERGENCE OF CURRENT AT ANY INPUT (X,Y)
C  LOCATION.  THE FLAG FOR THE APPROPRIATE DEPTH AND/OR CURRENT
C  INTERPOLATION SCHEME IS "IREALD" AND IS PASSED IN VIA THE COMMON BLOCK.
C
C   INPUT: X AND Y;    RETURNED: DR,UX,VY,DIVU
```

```
C
C   DEFINITIONS OF VARIABLES:
C      MX= NUMBER OF NODES IN X-DIRECTION (INCLUDES 1 ARTIFICIAL NODE).
C      NY= NUMBER OF NODES IN Y-DIRECTION (INCLUDES 2 ARTIFICIAL NODES).
C      IX= NUMBER OF X-LOCATION OF NODE ON DEPTH GRID.
C      IX1= IX+1
C      IY= NUMBER OF Y-LOCATION OF NODE ON DEPTH GRID.
C      IY1= IY+1
C      XI= ARRAY OF X-LOCATIONS OF GRID POINTS OF INPUT DEPTHS.
C      YI= ARRAY OF Y-LOCATIONS OF GRID POINTS OF INPUT DEPTHS.
C      DEP= ARRAY OF VALUES OF INPUT DEPTHS
C      X= X-LOCATION OF POINT OF INTEREST.
C      Y= Y-LOCATION OF POINT OF INTEREST.
C      DR= THE INTERPOLATED DEPTH AT THE POINT OF INTEREST
C      UX= THE INTERPOLATED CURRENT COMPONENT IN X-DIR.
C      VY= THE INTERPOLATED CURRENT COMPONENT IN Y-DIR.
C      DIVU= DIVERGENCE OF CURRENT VECTOR
C  NOTE: THIS IS AN INTERPOLATION OF ACTUAL DEPTHS, NOT BACKGROUND DEPTHS.
C
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      COMMON/AG/XI,YI,DEP,U,V
C      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C      COMMON/CC/ C
C      DIMENSION XI(134),YI(133),DEP(134,133),TEMP(16),XGRID(4)
C      DIMENSION YGRID(4),C(4,134),U(134,133),V(134,133),B(6)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE LSBFIT(MX,NY,XI,DEP,C)
C
C    THIS SUBROUTINE (Least Square Best FITting) EXECUTES OPTION
C  IBACKD=2, WHICH IS A LEAST SQUARES FIT OF A CUBIC FUNCTION TO ALL OF
C  THE INPUT DEPTHS AS THE BACKGROUND DEPTH (INVARIANT IN Y-DIRECTION).
C       DEPTH=C1 + C2 X + C3 X**2 + C4 X**3
C  THESE 4 COEFFICIENTS ARE RETURNED IN ARRAY C(4,134) WHICH IS DECLARED
C  IN CASE IBACKD=1.
C
C  INPUT: MX,NY,XI,DEP;    RETURNED: C
C
C     DIMENSION A(4,4),B(4),XI(134),DEP(134,133),C(4,134)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE LSTSQR(DEPTH,XGRID,YGRID,X,Y,DR,B)
C
C    THIS SUBROUTINE IS TRIBUTARY TO "DEPINP" AND EXECUTES OPTION
C  IREALD=4. IT PERFORMS A LEAST SQUARES SURFACE FIT ON THE SIXTEEN
C  DATA POINTS OF THE COMPUTATIONAL MOLECULE TO FORM A 6 COEFFICIENT
C  POLYNOMIAL.
C  G(X,Y)= A0 + A1 X + A2 Y + A3 X Y + A4 X**2 + A5 Y**2
C
C  INPUT: DEPTH,XGRID,YGRID,X,Y;    RETURNED: DR
C
C      DIMENSION XGRID(4),YGRID(4),DEPTH(16),A(6,6),B(6)
C      COMMON/DI/IBACKD,IREALD,IBREA,ICURRN
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE MAKEC(C)
C
```

```
C   THIS SUBROUTINE (MAKE Coefficients) FORMS THE ARRAY "C" WHICH
C  CONTAINS THE  COEFFICIENTS FOR A CUBIC SPLINE FIT TO BACKGROUND
C  TOPOGRAPHY.  FOR A POSSIBLE INTERPOLATION SCHEME OF BACKGROUND
C  DEPTH  THE ARRAY CONTAINS THE COEFFICIENTS OF A SINGLE CUBIC
C  POLYNOMIAL FOR THE ENTIRE BACKGROUND DETERMINED FROM A LEAST-SQUARES
C  ANALYSIS.   THIS SUBROUTINE ALSO READS THE LOCATIONS OF ALL THE NODES
C  FOR THE INPUT DEPTH MESH, AS WELL AS ALL OF THE DEPTHS AND/OR CURRENT
C  AT THESE NODES.
C
C RETURNED: C
C
C      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
C      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      COMMON/AG/XI,YI,DEP,U,V
C      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C      DIMENSION XI(134),YI(133),DEP(134,133),C(4,134),TEMP(134)
C      DIMENSION U(134,133),V(134,133),TEMP1(134),TEMP2(134)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C     SUBROUTINE MAKEQN(A,B,X,Y,D)
C
C   THIS SUBROUTINE (MAKE EQuatioN) SETS UP THE EQUATIONS FOR A LEAST
C  SQUARE FIT FOR A 6 COEFFICIENT POLYNOMIAL USED FOR OPTION IREALD=4.
C  THESE EQUATIONS ARE SOLVED IN THE CALLING PROGRAM.
C
C  INPUT: X,Y,D;    RETURNED: A,B
C
C     DIMENSION X(4),Y(4),D(16),A(6,6),B(6)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE MAKEQ2(A,B,XGRID,MX,NY,DEP)
C
C   TO FORM THE EQUATIONS FOR A LEAST-SQUARES FIT TO A FOUR COEFFICIENT
C  POLYNOMIAL FOR INTERPOLATION OF BACKGROUND DEPTH.  THIS CORRESPONDS TO
C  OPTION IBACKD=2. THESE EQUATIONS ARE SOLVED IN THE CALLING PROGRAM.
C
C      DIMENSION A(4,4),B(4),XGRID(134),DEP(134,133)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C       FUNCTION PCUBIC(XBAR)
C
C   FUNCTION PCUBIC (Polynomial-CUBIC) RETURNS A DEPTH FOR THE BACKGROUND
C  TOPOGRAPHY.  THE FLAG VARIABLE "IBACKD" WHICH CONTROLS THE OPTION CHOSEN
C  IS PASSED IN THROUGH THE COMMON BLOCK.
C
C  INPUT: XBAR;    RETURNED: PCUBIC
C
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      COMMON/AG/XI,YI,DEP,U,V
C      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
C      COMMON/CC/ C
C      DIMENSION XI(134),C(4,134),YI(133),DEP(134,133)
C      DIMENSION U(134,133),V(134,133)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
```

```
C      SUBROUTINE SPLINE(N,I,XI,C)
C
C    THIS SUBROUTINE IS PART OF AN EQUATION SOLVER THAT IS TRIBUTARY
C  TO SUBROUTINE "CUSPIP".  THIS ROUTINE IS USED FOR OPTION IBACKD=1.
C
C   INPUT: N,I,XI;    RETURNED: C
C
C      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
C      DIMENSION XI(MX),C(4,134),D(134),DIAG(134)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C       SUBROUTINE SPL4PT(X,XGRID,D1,D2,D3,D4,FX,DFDX)
C
C    THIS SUBROUTINE (SPLine 4 Points) DOES A CUBIC SPLINE OVER 4 NODES
C  (3 SEGMENTS) AND RETURNS AN INTERPOLATED VALUE.  THIS CORRESPONDS TO
C  OPTION IREALD=2 OR 3.
C
C    INPUT: X,XGRID,D1,D2,D3,D4
C    OUTPUT: FX,DFDX
C    DEFINITION OF VARIABLES:
C        X= THE LOCATION AT WHICH AN INTERPOLATED VALUE IS DESIRED.
C        XGRID(4)= AN ARRAY OF THE X-LOCATIONS OF THE 4 POINTS AT
C                 WHICH THE DEPTH IS KNOWN
C        D1,D2,D3,D4= THE KNOWN DEPTHS AT THE FOUR NODES BETWEEN
C                 WHICH AN INTERPOLATION IS TO BE DONE.
C        FX= THE INTERPOLATED DEPTH AT LOCATION X.
C        DFDX= FIRST DERIVATIVE OF DEPTH OR CURRENT W.R.T. X OR Y
C
C      DIMENSION XGRID(4),DX(3),A(2,2),B(2)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,FF,TEMP)
C
C   STORE QUANTITIES FOR LOCAL TRANSFORMATION IN 16-POINT LSTSQR
C
C   INPUT: IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,FF
C   OUTPUT: TEMP
C
C      DIMENSION FF(134,133),TEMP(16)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C  c)  SUBROUTINES USED FOR EQUATION SOLVING
C
C             GJSOLV - N x N GAUSS-JORDAN
C             SOLVE2 - 2 x 2 GAUSS-JORDAN
C             SOLVE - TRIDIAGONAL
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE GJSOLV(A,B,N)
C
C  THIS SUBROUTINE SOLVES AN N x N MATRIX VIA GAUSS-JORDAN ELIMINATION
C
C      INPUT: A,B,N;  OUTPUT: B
C
C  VARIABLE DEFINITION:
```

```
C        A= MATRIX OF COEFFICIENTS IN TERMS OF THE EQUATION SYSTEM
C        B= RIGHT-HAND-SIDE OF EQNS.--TO BE SOLVED, ALSO USED TO STORE
C           SOLVED VALUES
C        N= NUMBER OF UNKNOWNS
C      INTERNAL:
C        J=PIVOT ROW=PIVOT COLUMN
C        I=COLUMN NUMBER
C        K=NON-PIVOT ROW NUMBER
C      DIMENSION A(N,N), B(N)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE SOLVE2(A,B)
C
C    SUBROUTINE TO SOLVE A 2 x 2 MATRIX.  SIMILAR TO SUBROUTINE GJSOLV FOR
C  N=2 BUT MORE EFFICIENT AS IT IS LESS GENERAL.
C
C      DIMENSION A(2,2), B(2)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C
C      SUBROUTINE SOLVE(N,A1,A2,A3,B,FN)
C
C  SUBROUTINE TO SOLVE A TRIDIAGONAL MATRIX.
C
C  INPUT: N,A1,A2,A3,B;  RETURNED: FN
C
C  DEFINITION OF VARIABLES:
C    N= THE NUMBER OF UNKNOWNS WHICH ARE TO BE SOLVED
C    A1 = THE FIRST COEFFICIENT OF EACH ROW
C    A2 = THE MIDDLE COEFFICIENT IN EACH ROW
C    A3 = THE THIRD COEFFICIENT IN EACH ROW
C    B = THE RIGHT-HAND-SIDE OF THE EQUATIONS TO BE SOLVED
C    FN = SOLUTIONS OF EQUATION SYSTEM
C  EXAMPLE OF INPUT FORMAT (SAY N=6):
C     THE FIRST AND LAST ROWS ARE SPECIAL CASES.
C
C   <  A1(1)    A2(1)   A3(1)     0        0         0 >      { B(1) }
C   <  A1(2)    A2(2)   A3(2)     0        0         0 >      { B(2) }
C   <    0      A1(3)   A2(3)   A3(3)      0         0 >      { B(3) }
C   <    0        0     A1(4)   A2(4)    A3(4)       0 >   =  { B(4) }
C   <    0        0       0     A1(5)    A2(5)    A3(5)>      { B(5) }
C   <    0        0       0     A1(6)    A2(6)    A3(6)>      { B(6) }
C
C     COMPLEX B(N),FN(N),A1(N),A2(N),A3(N)
C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
```

```
C
C***********************************************************************
C     THIS PROGRAM IS DEVELOPED FOR THE DIFFRACTION AND REFRACTION IN
C     THE COASTAL REGION WITH VARIATION OF WATER DEPTH
C     VIA CURVILINEAR/CARTESIAN COORDINATES COMPUTATION
C***********************************************************************
C  NOTE: CERTAIN RELATIONSHIPS BETWEEN N AND M MUST BE MAINTAINED.
C      1) N+M .LE. 2000;   2) N .LE. 500
C  ALSO, WHEN USING CURVILINEAR COORDINATES DELTA SIGMA
C  MUST BE AN INTEGER MULTIPLE OF DELTA RHO.
C  i.e. DSIG=15  AND DRHO=10 IS NOT ALLOWABLE.
C
      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
      COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/AH/NUMSEC,IUNIT,X11,Y11,X21,Y21,TITLE
      COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      DIMENSION IUNIT(10),X11(10),Y11(10),X21(10),Y21(10)
      DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10)
      CHARACTER*80 TITLE
C
      WRITE(6,1)
    1 FORMAT(///' THIS IS A REMINDER!!!'//,' HAVE YOU PREPARED
     & FILES OF DEPTH.DAT AND LOC.DAT??'//,' HAVE YOU PREPARED
     & FILES OF CURRNX.DAT AND CURRNY.DAT'/' IF CURRENT FIELD IS
     & TO BE CONSIDERED??'//' INPUT (1-9) TO CONTINUE; 0 TO STOP'/)
      READ(5,*)IGOING
      IF(IGOING .EQ. 0) GO TO 1000
C
C THE UNIT DESIGNATIONS ARE AS FOLLOWS:
C         5 = THIS IS THE KEYBOARD
C         6 = THIS IS THE SCREEN
C         9 = THIS IS AN INPUT FILE CONTAINING THE DEPTHS
C        10 = THIS IS AN INPUT FILE CONTAINING GRID COORD.
C        11 = THIS IS AN INPUT FILE CONTAINING X-COMP. OF CURRENT
C        12 = THIS IS AN INPUT FILE CONTAINING Y-COMP. OF CURRENT
C FILES OF UNITS 11 AND 12 ARE NEEDED WHEN ICURRN = 1
C        13 = THIS IS AN INPUT FILE (MISCELLANEOUS INFO)
C        21-30 = THESE ARE OUTPUT FILES CONTAINING LOCATIONS,
C              AMPLITUDE, AND PHASE DATA FOR EACH PROFILE.
C
      OPEN(UNIT=9,NAME='DEPTH.DAT',STATUS='OLD')
      OPEN(UNIT=10,NAME='LOC.DAT',STATUS='OLD')
C
C  DEFINITION OF VARIABLE NAMES:
C
C     IBATCH= 0: INTERACTIVE MODE; 1: SEMI-INTERACTIVE; 2: BATCH MODE
C     IOPTCO= 0: CURVILINEAR COORDINATES
C             1: CARTESIAN COORDINATES (PROPAGATION DIRECTION)
C             2: CARTESIAN COORDINATES (FIXED)
C     IOPTBU,IOPTBD :UPWAVE AND DOWNWAVE LATERAL BOUNDARY CONDITION
C             0: OPEN BOUNDARY CONDITIONS
C             1: SOLID BOUNDARY CONDITIONS
C     AO= INITIAL WAVE AMPLITUDE (UNIT MUST BE CONSISTENT WITH G)
C     T= THIS IS THE WAVE PERIOD (UNIT MUST BE CONSISTENT WITH G)
C     ALPHAD (IN DEGREE)= INITIAL ANGLE OF ATTACK (CONVERTED
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C            INTERNALLY TO RADIANS).  NOTE: STANDING ON SHORE AND
C            FACING SEAWARD, ALPHA IS NEGATIVE FOR WAVES
C            COUNTER-CLOCKWISE FROM THE 12 O'CLOCK POSITION
C            AND POSITIVE FOR THOSE FROM THE CLOCKWISE AREA
C       TIDE=TIDE LEVEL REFERRED TO MEAN SEA WATER LEVEL
C       G= ACCELERATION DUE TO GRAVITY
C       MXGRID= THIS IS THE NUMBER OF ROWS (X=CONSTANT) OF
C          DEPTH DATA WHICH ARE TO BE INPUT
C       NYGRID= THIS IS THE NUMBER OF COLUMNS (Y=CONSTANT)
C          OF DEPTH DATA WHICH ARE TO BE INPUT
C       XO,YO= REFERENCE POINT OF REFERENCE LINE (CHOOSE POINT
C             AT THE UPWAVE SIDE OF INTERESTED AREA)
C       DSIG= DELTA SIGMA = THE GRID SIZE IN THE DIREON
C           OF WAVE PROPAGATION
C       DRHO= DELTA RHO = THE GRID SIZE PARRALEL TO THE
C           PHASE LINE
C       N= THE NUMBER OF NODES ALONG THE PHASE LINE.
C          NOTE: N HAS INTERMEDIATE VALUES BEFORE THE ABOVE
C               DESCRIPTION IS CORRECT
C       M= MAX NUMBER OF MARCHING STEPS IN PROPAGATION
C       S1,S2= BOTTOM SLOPE AT FIRST ROW OF INPUT DEPTHS
C          (NEAR SHORE) AND LAST ROW (DEEP WATER) - USED
C          ONLY FOR CUBIC SPLINE OF BACKGROUND DEPTH
C       DC= DEPTH AT CONSTANT REGION (DEEP WATER)
C       DBASE=DEPTH AT BASELINE
C       U= X-COMPONENT OF CURRENT
C       V= Y-COMPONENT OF CURRENT
C       IP=NUMBER OF TIME STEPS TO SKIP BETWEEN INTERPOLATIONS
C       IFRCT,XDAMP=FLAG FOR BOTTOM FRICTION AND LOCATION AT
C          WHICH BOTTOM FRICTION EFFECTS START TO BE CALCULATED
C       FRCT= BOTTOM FRICTION FACTOR
C       TITLE= TITLE OF OUTPUT DATA FILES
C       NTRUC= NUMBER OF NODES ON TRUNCATED PHASE LINE
C       IDEPM,IPLINE= PRINTING FLAGS (1: PRINT ON SCREEN; 0:NO PRINT-OUT)
C       IBKWTR=FLAG OF PRESENCE OF BREAKWATER
C              0 : NO BREAKWATER AT ALL
C              # : NO. OF BREAKWATERS WILL BE ENCOUNTERED DURING
C                  COMPUTING (LIMITED TO 5)
C       IBKWPT(I)= NO. OF POINTS TO DESCRIBE LINEAR SEGMENTS OF
C                  I-TH BREAKWATER (2 TO 10, IF ANY)
C       XBW(I,J),YBW(I,J)=COORDINATES OF J-TH POINT ON I-TH BREAKWATER
C       ICURRN=FLAG OF CURRENT FIELD
C              1 : EFFECTS OF CURRENT FIELD ON WAVE CONSIDERED
C              0 : NO CURRENT EFFECTS
C       C(4,MX)= THIS IS THE ARRAY OF COEFFICIENTS USED IN A CUBIC SPLINE
C         INTERPOLATION. Ex. F(x)= C(1,I)+C(2,I)x+C(3,I)x*x+C(4,I)x*x*x.
C       NN=MAX POSSIBLE NUMBER OF NODES TO LANDWARD
C
      WRITE(6,101)
  101 FORMAT(' WHICH MODE DO YOU WANT??'//,
     & ' 2=BATCH; FROM THIS POINT ON YOU CAN NOT ALTER ANY PARAMETERS'/
     & ' 1=SEMI-INTERACTIVE; NO DATA INPUT FROM KEYBOARD, BUT AT '/
     & '   SEVERAL BREAKPOINTS PROGRAM ALLOWS YOU TO ADJUST PARAMETERS'/
     & ' 0=INTERACTIVE; ALL DATA INPUT FROM KEYBOARD EXCEPT DEPTH.DAT,'/
     & '   LOC.DAT, AND/OR CURRNX.DAT AND CURRNY.DAT. YOU CAN ALSO '/
     & '   ADJUST PARAMETERS'/)
      READ(5,*) IBATCH
      IF(IBATCH .NE. 0) GO TO 102
      IUNIT1=5
      OPEN(UNIT=13,NAME='IN.DAT',STATUS='NEW')
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      GO TO 113
  102 IUNIT1=13
      IF(IBATCH .EQ. 2)WRITE(6,120)
  120 FORMAT(5(/),10X,'PLEASE WAIT!!'/10X,'PROGRAM IS RUNNING.'/
     &,50('*'))
      OPEN(UNIT=13,NAME='IN.DAT',STATUS='OLD')
  113 IF(IBATCH .EQ. 0) WRITE(6,110)
  110 FORMAT(' CHOOSE OPTION FOR COORDINATES (IOPTCO)'/' 0:CURVILINEAR;
     &'/' 1:CARTESIAN (PROPAGATION DIRECTION);'/' 2:FIXED CARTESIAN'/)
      READ(IUNIT1,*)IOPTCO
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IOPTCO
      IF(IBATCH .EQ. 0) WRITE(6,111)
  111 FORMAT(' CHOOSE OPTION FOR B.C.'/' (IOPTBU:UPWAVE-SIDE BOUNDARY,
     & IOPTBD:DOWNWAVE-SIDE BOUNDARY);'/' 0:OPEN; 1:SOLID'/)
      READ(IUNIT1,*)IOPTBU,IOPTBD
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IOPTBU,IOPTBD
      IF(IBATCH .EQ. 0) WRITE(6,114)
  114 FORMAT(' INPUT:A0,T,ALPHAD,G,TIDE, FREE FORMAT'/)
      READ(IUNIT1,*)A0,T,ALPHAD,G,TIDE
      IF(IUNIT1 .EQ. 5) WRITE(13,*)A0,T,ALPHAD,G,TIDE
      IF(IBATCH .EQ. 0) WRITE(6,103)
  103 FORMAT(' INPUT:MXGRID,NYGRID;FREE FORMAT'/)
      READ(IUNIT1,*)MXGRID,NYGRID
      IF(IUNIT1 .EQ. 5) WRITE(13,*)MXGRID,NYGRID
      IF(IBATCH .EQ. 0) WRITE(6,104)
  104 FORMAT(' INPUT:X0,Y0,DSIG,DRHO,N,M,S1,S2,DC,DBASE;FREE FORMAT'/)
      READ(IUNIT1,*)X0,Y0,DSIG,DRHO,N,M,S1,S2,DC,DBASE
      IF(IUNIT1 .EQ. 5) WRITE(13,*)X0,Y0,DSIG,DRHO,N,M,S1,S2,DC,DBASE
      IF(IBATCH .EQ. 0) WRITE(6,105)
  105 FORMAT(' INPUT:IP; FREE FORMAT'/)
      READ(IUNIT1,*)IP
      IF(IUNIT1 .EQ. 5) WRITE(13,*)IP
      IF(IBATCH .EQ. 0) WRITE(6,5)
    5 FORMAT(' ENTER CHOICE FOR BACKGROUND DEPTH INTERPOLATION :'/
     *' IBACKD = 0 :PLANE BEACH WITH SLOPE = 0.01 (DEBUGGING)'/
     *'        = 1 :CUBIC SPLINE OVER AVG. DEPTH AT EACH ROW'/
     *'        = 2 :LEAST SQUARE CUBIC EQN. IN X-DIRECTION.'//
     *' ENTER IBACKD:'/)
      READ(IUNIT1,*) IBACKD
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IBACKD
      IF(IBATCH .EQ. 0) WRITE(6,7)
    7 FORMAT(//' ENTER CHOICE FOR ACTUAL DEPTH INTERPOLATION :'/
     *' IREALD = 0 :PLANE BEACH WITH SLOPE = 0.01 (DEBUGGING)'/
     *'        = 1 :LINEAR AVG. OF 4 SURROUNDING GRID POINTS.'/
     *'        = 2 :USES A 16-POINT GRID FOR A CUBIC SPLINE ACROSS'/
     *'        EACH OF 4 ROWS AND THEN THE COLUMNS OF THE DESIRED Y'/
     *'        = 3 :LIKE IREALD=2 EXCEPT THE SPLINE IS DONE ON '/
     *'        THE COLUMNS FIRST AND THEN THE ROW OF THE DESIRED X'/
     *'        = 4 :A LEAST SQUARE FIT OF THE 16-POINT GRID TO'/
     * '       A 6-COEFFICIENT DEPTH EXPRESSION'//
     * ' ENTER IREALD:'/)
      READ(IUNIT1,*) IREALD
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IREALD
      IF(IBATCH .EQ. 0) WRITE(6,106)
  106 FORMAT(' INPUT:IDEPM,IPLINE; FREE FORMAT'/)
      READ(IUNIT1,*)IDEPM,IPLINE
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IDEPM,IPLINE
      IF(IBATCH .EQ. 0) WRITE(6,109)
  109 FORMAT(' INPUT:IFRCT,XDAMP,FRCT'/)
      READ(IUNIT1,*)IFRCT,XDAMP,FRCT
```

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      IF(IUNIT1 .EQ. 5) WRITE(13,*) IFRCT,XDAMP,FRCT
      IF(IBATCH .EQ. 0) WRITE(6,35)
   35 FORMAT(' ENTER IBREAK = 0 :NO WAVE BREAKING,'/
     * '              = 1 :WAVE BREAKING IS CONSIDERED'/)
      READ(IUNIT1,*) IBREAK
      IF(IUNIT1 .EQ. 5) WRITE(13,*) IBREAK
      IF(IBATCH .EQ. 0) WRITE(6,36)
   36 FORMAT(' ENTER ICURRN = 1 :PRESENCE OF CURRENT FIELD'/
     * '              = 0 :NO PRESENCE OF CURRENT FIELD.'/)
      READ(IUNIT1,*) ICURRN
      IF(IUNIT1 .EQ. 5) WRITE(13,*) ICURRN
      IF(ICURRN .EQ. 0) GO TO 37
      OPEN(UNIT=11,NAME='CURRNX.DAT',STATUS='OLD')
      OPEN(UNIT=12,NAME='CURRNY.DAT',STATUS='OLD')
   37 DALPH=ALPHAD
      DC=DC+TIDE
      DBASE=DBASE+TIDE
      NTRUC=N
C
C CONVERT ANGLE TO RADIANS
C
      ALPHA=ALPHAD*3.1415926/180.
      MX=MXGRID+1
      NY=NYGRID+2
      NN=M
      IF(IBATCH .EQ. 0) WRITE(6,115)
  115 FORMAT(' ENTER IBKWTR = 0 :NO PRESENCE OF BREAKWATER;'/
     & '              = # :TOTAL NO. OF BREAKWATERS, MAX. NO. = 5'/)
      READ(IUNIT1,*)IBKWTR
      IF(IUNIT1 .EQ. 5) WRITE(13,*)IBKWTR
      IF(IBKWTR .EQ. 0) GO TO 117
      DO 118 I=1,IBKWTR
      IF(IBATCH .EQ. 0) WRITE(6,116)I
  116 FORMAT(' ENTER TOTAL POINTS OF LINEAR SEGMENTS OF BREAKWATER
     & NO. =',I5,/' AND ITS COORDINATES, FIRST POINT STARTS FROM
     & THE TIP OF THE BREAKWATER.'/' NO. OF POINTS CAN BE FROM 2
     & TO 10'/' INPUT IBKWPT(I),XBW(I,L),BYW(I,L),L=1,IBKWPT(I)'/)
      READ(IUNIT1,*)IBKWPT(I),(XBW(I,L),YBW(I,L),L=1,IBKWPT(I))
      IF(IUNIT1 .EQ. 5)
     & WRITE(13,*)IBKWPT(I),(XBW(I,L),YBW(I,L),L=1,IBKWPT(I))
  118 CONTINUE
  117 IF(IBATCH .EQ. 0) WRITE(6,387)
  387 FORMAT(' ENTER TITLE, MAX. OF 80 CHARACTERS'//)
      READ(IUNIT1,'(A)') TITLE
      IF(IUNIT1 .EQ. 5) WRITE(13,' (A)') TITLE
      IF(IBATCH .EQ. 0) WRITE(6,396)
 396  FORMAT(' INPUT THE NUMBER OF PROFILES TO BE INTERPOLATED,'/
     * '  UP TO 10 PROFILES IS ALLOWED ON ONE RUN'/)
      READ(IUNIT1,*) NUMSEC
      IF(IUNIT1 .EQ. 5) WRITE(13,*) NUMSEC
C
C ALLOW USER TO REVIEW AND CHANGE THE VALUES OF THE DEFAULT PARAMETERS.
C
      IF(IBATCH .EQ. 2) GO TO 389
      WRITE(6,20)
   20 FORMAT(' DO YOU WISH TO REVIEW THE DEFAULT PARAMETERS?'/
     * '   ENTER 1 FOR YES, 0 FOR NO'/)
      READ(5,*)I
      IF (I.NE.1) GO TO 389
      CALL REVIEW
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  389 DO 441 JJJ=1,10
      IUNIT(JJJ)=20+JJJ
  398 IF(IBATCH .EQ. 0) WRITE(6,397)JJJ
  397 FORMAT(' INPUT TWO END POINTS OF DESIRED PROFILE NO.= ',I4,':'/
     * ' X1,Y1 AND X2,Y2'/)
      READ(IUNIT1,*) X11(JJJ),Y11(JJJ),X21(JJJ),Y21(JJJ)
      IF(IUNIT1 .EQ. 5) WRITE(13,*)X11(JJJ),Y11(JJJ),X21(JJJ),Y21(JJJ)
      IF(JJJ.GE.NUMSEC) GO TO 399
  441 CONTINUE
C
C CHECK FOR VALUES WHICH ARE BEYOND THE PROGRAM'S LIMITATIONS
C AND SUBSTITUTE ACCEPTABLE VALUES
C
  399 IF(N.LE.500) GO TO 25
      N=500
      WRITE(6,28)
   28 FORMAT(' NO. OF NODES EXCEEDS 500, N = 500 HAS BEEN USED'/)
   25 IF(NN+N .LT. 2000) GO TO 60
      NN=1500
      IF(M.LE.NN) GO TO 60
      M=NN
      WRITE(6,27)
   27 FORMAT(' NO. OF STEPS EXCEEDS 1500, M = 1500 HAS BEEN USED'/)
   60 CALL MAKEPL
      CLOSE(UNIT=7)
      CLOSE(UNIT=8)
      CLOSE(UNIT=20)
      CLOSE(UNIT=21)
      CLOSE(UNIT=22)
      CLOSE(UNIT=23)
      CLOSE(UNIT=24)
      CLOSE(UNIT=25)
      CLOSE(UNIT=26)
      CLOSE(UNIT=27)
      CLOSE(UNIT=28)
      CLOSE(UNIT=29)
      CLOSE(UNIT=30)
 1000 STOP
      END
C
C
      SUBROUTINE MAKEPL
      COMPLEX FO(500),FN(500),C1,C3,C4,A1(500),A2(500),DTHE
      COMPLEX AMPRD(500),A3(500),B(500),CB,VV,V1,V2,V3
      COMPLEX C5(5),C6(5),C7(5),C8(5),C9(5),C10(5),C11(5),C12(5)
      COMPLEX C50(5),C60(5),C70(5),C80(5),C90(5),C100(5),C110(5),C120(5)
      COMPLEX CD1,CD2,CD3,CD4
      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
      COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/AH/NUMSEC,IUNIT,X11,Y11,X21,Y21,TITLE
      COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      COMMON/CC/ C
      DIMENSION ARO(500),ARN(500),ASN(500),ASO(500),IBROKN(500)
      DIMENSION XX(2000),XG(500),YY(2000),YG(500),PHASEL(2000)
      DIMENSION CG(2000),WKN(2000),DEPM(2000),THETA(2000),AMPM(2000)
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```
      DIMENSION XOLD(500),YOLD(500),XNEW(500),YNEW(500)
      DIMENSION AMPLT(500),PHASE(500),WKFS(500),DNODE(500)
      DIMENSION C(4,134),XI(134),YI(133),DEP(134,133),U(134,133)
      DIMENSION IUNIT(10),X11(10),Y11(10),X21(10),Y21(10),V(134,133)
      DIMENSION AM2(500),AM1(500),PGC1(500),PGC0(500),PGC(2000)
      DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10),NUW(5),NUW1(5),IBK(5)
      CHARACTER*80 TITLE
      CHARACTER*9 OUTFIL(10)
      DATA OUTFIL/'OUT01.DAT','OUT02.DAT','OUT03.DAT','OUT04.DAT',
     & 'OUT05.DAT','OUT06.DAT','OUT07.DAT','OUT08.DAT','OUT09.DAT',
     & 'OUT10.DAT'/
C
C CALL SUBROUTINE TO READ NODE LOCATIONS (XI & YI), DEPTHS AND/OR CURRENT
C AT EACH OF THE NODES (DEP,U,V), AND THEN GENERATE BACKGROUND DEPTHS
C IDIRC= FLAG FOR DIRECTION OF INCIDENT WAVES; IDIRC=1 FOR POSITIVE
C        INCIDENT ANGLE; IDIRC=-1 FOR NEGATIVE INCIDENT ANGLE
      CALL MAKEC(C,DEP,XI,YI)
      W=0.5
      GAMA=DSIG/DRHO**2
      INCR=DSIG/DRHO
      IF(IOPTCO .NE. 0) INCR=1
      MM=10
      DRHO1=DRHO/MM
      DSIG1=DSIG/MM
      PAI=3.14159265
      OMEGA=2.*PAI/T
      MX1=MX-1
      COSINE=COS(ALPHA)
      SINE=SIN(ALPHA)
      ICOUNT=0
C
C**************************************************************************
C AT ONE GRID POINT CALL SUBROUTINE USING DEPTH (D2), FREQUENCY (OMEGA),
C AND GRAVITY (G) TO SOLVE DISPERSION RELATION AND RETURN WAVENUMBER
C (WK), AND GROUP VELOCITY (GC)
C**************************************************************************
C
      D2=DC+TIDE
      CALL WAVENO(D2,WK,GC,PGCC,IDEPTH)
      CGDEEP=GC
      WKO=WK
      PGCDC=PGCC
C
C SEE EQN. 16  IN TSAY,TING-KUEI AND P.L-F LIU, "NUMERICAL SOLUTION OF
C WATER-WAVE REFRACTION AND DIFFRACTION PROBLEMS IN THE PARABOLIC
C APPROXIMATION", JOURNAL OF GEOPHYSICAL RESEARCH, 87, 7932-7940, 1982.
C
   60 BETA=WKO*SIN(ALPHA)
      IDIRC=1
      IF(BETA .LT. 0.) IDIRC=-1
      DRHO1=IDIRC*DRHO1
C
C INITIALIZE ARRAYS
C
      DO 69 I=1,2000
      PHASEL(I)=0.
   69 CONTINUE
      DO 70 I=1,N
      FO(I)=1.0
      XOLD(I)=XI(MX)
```

```
      YOLD(I)=YI(1)
      ARO(I)=1.
      ASO(I)=0.
      IBROKN(I)=0
C     WKFS(I)=0.
   70 CONTINUE
C
C XO AND YO ARE THE LOCATION OF THE REFERENCE POINT ON REFERENCE LINE
C
      X=XO
      Y=YO
      X1=XO
      Y1=YO
      ISHORE=0
      NNN=1500
C
C LOOP TO CONSTRUCT REFERENCE LINE BY ADDING NODES ON EITHER SIDE
C OF THE REFERENCE POINT.
C NNN=THE POSSIBLE MAXIMUM NUMBER OF NODES ADDED ON THE SEAWARD AND
C     LANDWARD SIDES OF THE REFERENCE POINT ALONG THE PHASE LINE.
C
      DPHAS1=0.
      DPHAS2=0.
      DO 210 I=1,NNN
      IF(I .EQ. 1) GO TO 160
      IF(I .GT.M .AND. I .GT. N) GO TO 211
C
C LOOP 150 DIVIDES THE CALCULATION OF THE ADDITION OF A POINT TO THE
C PHASE LINE INTO MM (=10) INCREMENTS TO GAIN ACCURACY. A CHECK IS
C ALSO DONE ON LAND-WARD POINTS TO SEE IF IT REACHED THE SHORE.  IF
C NOT THEN THE REST OF LOOP 210 (OUTER LOOP) IS EXECUTED.
C
      DO 150 K=1,MM
C
C NOTE: MM=10 = THE NUMBER OF CALCULATION STEPS DONE TO COVER ONE GRID
C INCREMENT (EX. BREAK EACH GRID INTO TEN SUB-PARTS FOR ACCURACY.
C XLB = FARTHEST EXTENT OF NEAR FIELD IN X-DIRECTION
C
      IF(I .GT. M) GO TO 110
      IF(ISHORE .NE. 0) GO TO 220
      D2=PCUBIC(X)
      IF(D2 .LE. 0.) GO TO 73
      CALL WAVENO(D2,WK2,GC2,PGC2,IDEPTH)
C
C CALL SUBROUTINE TO CALCULATE ANGLE OF INCIDENCE
C
  100 CALL CURVIL(BETA,WK2,THETA2,-DRHO1,DX,DY,IOPTCO)
      IF(IOPTCO .NE. 1) GO TO 71
      DX=-DSIG1*COSINE
      DY=DSIG1*SINE
      DPHAS1=DPHAS1+WK2*(-COS(THETA2)*DX+SIN(THETA2)*DY)
      GO TO 72
   71 IF(IOPTCO .NE. 2) GO TO 72
      DX=-DSIG1
      DY=0.
      DPHAS1=DPHAS1-WK2*COS(THETA2)*DX
C
C INCREMENT LOCATION TO FIND NEXT POINT IN LANDWARD DIRECTION
C
   72 X=X+DX
```

```
      Y=Y+DY
C
C MAKE SURE THAT POINT HAS NOT REACHED SHORE LINE
C
      IF(D2 .GT. 0.) GO TO 110
   73 ISHORE=I
      IS=NNN-I+2
      M=I-1
      YYY=Y
      IF(IOPTCO .EQ. 0)YYY=Y+IDIRC*I*DRHO
      IF(IBATCH .NE. 2) WRITE(6,90) I,X,YYY,M
   90 FORMAT(1X,' REFERENCE LINE HAS REACHED SHORELINE AT
     & MARCHED STEP =',I5,' (X,Y) = ',2F10.2//' NO. OF MARCHING
     & STEP, M HAS BEEN CHANGED TO NEW VALUE = ',I5///)
  110 IF(I .GE. N+1) GO TO 150
C
C X1 = X0 INITIALLY AND IS INCREMENTED BY DX (DX FROM CURVIL).
C CHECK IF POINT IS IN NEAR FIELD
C
  220 D3=PCUBIC(X1)
      CALL WAVENO(D3,WK3,GC3,PGC3,IDEPTH)
C
C CALL SUBROUTINE TO GET ANGLE OF INCIDENCE
C
  130 CALL CURVIL(BETA,WK3,THETA3,DRHO1,DX,DY,IOPTCO)
      IF(IOPTCO .NE. 1) GO TO 74
      DX=DRHO1*SINE
      DY=DRHO1*COSINE
      DPHAS2=DPHAS2+WK3*(-COS(THETA3)*DX+SIN(THETA3)*DY)
      GO TO 75
   74 IF(IOPTCO .NE. 2) GO TO 75
      DX=0.
      DY=DRHO1
      DPHAS2=DPHAS2+ABS(BETA*DY)
C
C INCREMENT LOCATION TO ADD POINT IN SEAWARD DIRECTION
C
   75 X1=X1+DX
      Y1=Y1+DY
  140 FORMAT(1X,8E15.6)
  150 CONTINUE
      IF(I .NE. M) GO TO 240
      YYY=Y
      IF(IOPTCO .EQ. 0)YYY=Y+IDIRC*(I-1)*DRHO
      IF(IBATCH .EQ. 2) GO TO 240
      WRITE(6,230)X,YYY,M
  230 FORMAT(2X,'( ',F12.3,' , ',F12.3,' )',' IS THE CLOSEST DISTANCE
     & FROM SHORE'/' WHERE CALCULATIONS CAN BE DONE FOR M= ',I5/'
     & WARING: MAX. M IS 1500'//)
      CALL ICHECK(M)
      WRITE(6,231)M,N
  231 FORMAT(////' CALCULATION HAS BEEN CONTINUING FOR NEW M = '
     & ,I5,'  AND N = ',I5//)
  240 IF(I .NE. N)GO TO 160
      IF(IBATCH .EQ. 2) GO TO 160
      WRITE(6,241)X1,Y1,N
  241 FORMAT(2X,'( ',F12.3,' , ',F12.3,' )',' IS THE FARTHEST DISTANCE
     & FROM SHORE'/' WHERE CALCULATIONS CAN BE DONE FOR N= ',I5/'
     & WARING: MAX. N IS 500'//)
      CALL ICHECK(N)
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      WRITE(6,242)M,N
  242 FORMAT(////' CALCULATION HAS BEEN CONTINUING FOR M = ',I5,
     & '  AND NEW N = ',I5//)
C
C NOTE: II VARIES FROM NNN TO 1
C RECALL: ARRAYS XX(NN) AND YY(NN) STORE THE LOCATIONS
C OF THE NODE POINTS ON THE REFERENCE LINE.
C
  160 IF(ISHORE .NE. 0 .OR. I .GT. M) GO TO 189
      II=NNN-I+1
      XX(II)=X
      YY(II)=Y
C
C CALCULATE VALUES OF WAVE PARAMETERS
C
      D2=PCUBIC(X)
      CALL WAVENO(D2,WK2,GC2,PGC2,IDEPTH)
C
C CALL SUBROUTINE TO RETURN ANGLE OF INCIDENCE
C
      CALL CURVIL(BETA,WK2,THETA2,-DRHO1,DX,DY,IOPTCO)
C
C STORE VALUES OF PARAMETERS JUST CALCULATED FOR NODE M+1.
C THESE VALUES ARE FOR LOCATION XX(II),YY(II)
C RECALL: DEPM='DEPTH-MODIFIED'= THE BACKGROUND TOPOGRAPHY
C
      PHASEL(II)=PHASEL(II)+DPHAS1
      WKN(II)=WK2
      THETA(II)=THETA2
      CG(II)=GC2
      DEPM(II)=D2
      PGC(II)=PGC2
      AMPM(II)=SQRT(CGDEEP/GC2)*SQRT(ABS(COS(ALPHA)/COS(THETA2)))
C
C CHECK IF TOTAL NUMBER OF DESIRED POINTS IS EXCEEDED THE LIMIT
C RECALL: IK RANGES FROM NNN TO NNN+N-1
C STORE SEAWARD POINTS IN TOP PART OF ARRAYS XX,YY
C
  189 IF(I .GT. N) GO TO 210
      IK=NNN+I-1
      XX(IK)=X1
      YY(IK)=Y1
C
C CALCULATE VALUES OF WAVE PARAMETERS
C
      D3=PCUBIC(X1)
      CALL WAVENO(D3,WK3,GC3,PGC3,IDEPTH)
C
C CALCULATE NEW ANGLE OF INCIDENCE.
C
      CALL CURVIL(BETA,WK3,THETA3,DRHO1,DX,DY,IOPTCO)
C
C STORE VALUES OF THE WAVE PARAMETERS JUST FOUND
C
      PHASEL(IK)=PHASEL(IK)+DPHAS2
      WKN(IK)=WK3
      THETA(IK)=THETA3
      CG(IK)=GC3
      DEPM(IK)=D3
      PGC(IK)=PGC3
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      AMPM(IK)=SQRT(CGDEEP/GC3*ABS(COS(ALPHA)/COS(THETA3)))
  210 CONTINUE
C
C RECALL: IM=I= INDEX FROM LOOP 210.  II=NNN-I+1
C XX(II),YY(II) = LOCATION OF FARTHEST OUT NODE ON REFERENCE LINE
C IN LANDWARD DIRECTION.
C
  211 IF(ISHORE .EQ. 0) IS=NNN-M+1
C
C PRINT OUT THE PROFILE OF THE BACKGROUND TOPOGRAPHY BENEATH THE NODES
C ON THE LANDWARD EXTENSION OF THE REFERENCE LINE.
C
      MII=NNN+N-1
      IF(IBATCH .EQ. 2) GO TO 270
      IF(IDEPM.NE.1) GO TO 270
      WRITE(6,250)
  250 FORMAT(' THE MODIFIED WATER DEPTH AT X,( X , DEPTH)')
      WRITE(6,*) (XX(L),DEPM(L),L=IS,MII)
  270 XG(1)=XX(NNN)
      YG(1)=YY(NNN)
      IF(IBATCH .EQ. 2) GO TO 393
      IF(IPLINE.NE.1) GO TO 395
      WRITE(6,380)
 380  FORMAT(' THESE ARE POINTS ON THE REFERENCE LINE: (X,Y) ')
      WRITE(6,*) (XX(L),YY(L),L=IS,MII)
C
C ALLOW USER TO TRUNCATE EXCESS NODE POINTS OFF THE SEAWARD END OF THE
C REFERENCE LINE
C
  395 WRITE(6,385)N
  385 FORMAT(' THE NUMBER OF NODES IS ',I5,' ENTER NEW NUMBER')
  390 FORMAT(I6)
      CALL ICHECK(N)
      IF(IBATCH .NE. 2) WRITE(6,392)N,M
  392 FORMAT(' N= ',I5,'  M= ',I5)
  393 C2=(1.-W)/W
      III=NNN
      N1=N-1
C
C ALLOW USER TO VIEW THE ACTUAL AND BACKGROUND TOPOGRAPHY BENEATH SOME
C PROFILE(S) WITHIN THE DOMAIN.
C
      IF(IBATCH .EQ. 2) GO TO 401
      WRITE(6,410)
  410 FORMAT(' TO VIEW THE TOPOGRAPHY BENEATH ANY SECTIONS'/
     * '         ENTER 1, ELSE ENTER 0.'//'  CAUTION: IF YOUR
     * FACILITY IS NOT GRAPHICALLY COMPATIBLE TO '/
     *' TEKTRONIX MODEL 4014-1, ENTER 0')
      READ(5,*) ISIDVW
      IF(ISIDVW .EQ. 0) GO TO 401
      CALL SIDEVW(NUMSEC,X11,Y11,X21,Y21)
  401 CONTINUE
C
C ALL INPUT INFORMATION ALTERED WILL BE STORED IN THE OUTPUT FILES
C
      DO 415 JJJ=1,10
      IUN=JJJ+20
      IF(JJJ .GT. NUMSEC) GO TO 430
      OPEN(UNIT=IUN,NAME=OUTFIL(JJJ),STATUS='NEW')
      WRITE(IUN,431)TITLE,AO,T,DALPH,G,TIDE,XO,YO,N,NN,M
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      WRITE(IUN,432)DSIG,DRHO,IOPTCO,IOPTBU,IOPBD,IBACKD,IREALD,IBREAK,
     & ICURRN,IFRCT,XDAMP,FRCT,IBKWTR
      IF(IBKWTR .EQ. 0) GO TO 437
      DO 436 IB=1,IBKWTR
  436 WRITE(IUN,435)IB,IBKWPT(IB),(XBW(IB,L),YBW(IB,L),L=1,IBKWPT(IB))
  437 WRITE(IUN,433) X11(JJJ),Y11(JJJ),X21(JJJ),Y21(JJJ)
      WRITE(IUN,434)
  415 CONTINUE
  431 FORMAT(//5X,A80///,5X,' AMPLITUDE = ',F10.3,'  PERIOD = ',F10.3,
     & //5X,' ANGLE = ',F8.3,' GRAVITY = ',F8.3,'  TIDE = ',F10.3//
     & ,5X,' REFERENCE POINT = ( ',F12.3,' , ',F12.3,' )',//,5X,
     & ' N = ',I5,' NN = ',I5, ' M = ',I5)
  432 FORMAT(//5X,' DSIG = ',F8.3,' DRHO = ',F8.3,' IOPTCO = ',I3,
     & ' IOPTBU = ',I3,' IOPTBD = ',I3,//5X,' IBACKD = ',I3,' IREALD = '
     & ,I3,' IBREAK = ',I3,' ICURRN = ',I3,//5X,' IFRCT = ',I3,' XDAMP =
     & ',F10.3,' FRCT = ',E12.4,' IBKWTR = ',I3)
  435 FORMAT(//5X,' BREAKWATER NO. = ',I3,5X,'POINTS ON THE BREAKWATER
     &=',I4,//,6F12.4)
  433 FORMAT(//5X,' SECTION FROM ( ',F11.3,' , ',F11.3,') TO ( ',
     & F11.3,' , ',F12.3,')')
  434 FORMAT(//,'         X - COORD.      Y - COORD.
     &    AMPLITUDE            DEPTH      PHASE VALUE')
  430 DO 402 I=1,N
      AM1(I)=AMPM(NNN+I-1)
      PGC0(I)=PGC(NNN+I-1)
  402 CONTINUE
C
C INITIALIZE INDEX FOR BREAKWATER
C
      DO 403 I=1,IBKWTR
      NUW(I)=0
      NUW1(I)=0
      IBK(I)=0
      C50(I)=0.
      C60(I)=0.
      C70(I)=0.
      C80(I)=0.
      C90(I)=0.
      C100(I)=0.
      C110(I)=0.
      C120(I)=0.
  403 CONTINUE
C
C  NUW(I) = NUMBER OF POINTS ON THE UPWAVE SIDE AT PRESENT COMPUTING
C      AT I-TH BREAKWATER
C  NUW1(I) = NUMBER OF POINTS ON THE UPWAVE SIDE AT PREVIOUS COMPUTING
C      AT I-TH BREAKWATER
C  IDM = 0 :BREAKWATER HAS NOT BEEN ENCOUNTERED
C      IF GREATER THAN 0 : (IDM) BREAKWATERS HAVE BEEN ENCOUNTERED
C  IBK(I) = FLAG FOR I-TH BRKWTR, 1: ENCOUNTERED; 0: NOT YET
C
C START SECOND MAJOR LOOP OF PROGRAM WHICH MODELS THE MOVEMENT OF THE
C COMPUTATIONAL LINE TOWARD SHORE. RECALL: M IS THE NUMBER OF FORWARD
C STEPS TO COVER THE AREA OF INTEREST.
C
      DO 750 I=1,M
      IDM=0
      IF(IBATCH .NE. 2) WRITE(6,901) I
  901 FORMAT(' MARCHED STEP= ',I5)
      IF(I .EQ. 1) GO TO 530
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      CALL BDYGRD(XG,YG,THETA,MX,XI,C,XLB,IOPTCO,COSINE,SINE)
C RECALL: N IS THE NUMBER OF NODES IN COMPUTATION LINE = THE DIMENSION
C OF THE MATRIX USED TO SOLVE FOR THE DIFFRACTION FACTOR (F)
C
      III=III-INCR
C
C STORE VALUES IN 'OLD' ARRAY BEFORE CALCULATION OF VALUES IN NEXT ROW.
C
      DO 520 K=1,N
      FO(K)=FN(K)
      XOLD(K)=XNEW(K)
      YOLD(K)=YNEW(K)
      ASO(K)=ASN(K)
      ARO(K)=ARN(K)
      AM1(K)=AM2(K)
      PGCO(K)=PGC1(K)
  520 CONTINUE
C
C LOOP START HERE FOR I=1 (NO OLD VALUES TO STORE ON THE FIRST STEP).
C
  530 DY=YY(III)-YG(1)
      DPHASE=-DY*BETA
      IF(IOPTCO .NE. 0) DPHASE=0.
      IF(I .NE. 1) GO TO 560
      IX=1
      IX1=2
      IY=2
      IY1=3
C
C LOOP TO GENERATE VALUES FOR A1(N), A2(N), A3(N), B(N), AND AMPLT(N)
C
  560 DO 630 J=1,N
C
C  IDN = FLAG OF ENCOUNTERING OF BREAKWATER BETWEEN ANY TWO POINTS
C       ON A COMPUTATIONAL LINE
C       = 0 NO PRESENCE OF BREAKWATER
C       = 1 A BREAKWATER IS ENCOUNTERED
C
      IDN=0
      IJ=III+J-1
C
C PREPARE INFORMATION FOR EVERY PONIT ON THE COMPUTATIONAL LINE
C
      IF(IOPTCO .EQ. 1) GO TO 563
      IF(IOPTCO .EQ. 2) GO TO 561
      XG(J)=XX(IJ)
      YG(J)=YY(IJ)-DY
      GC2=CG(IJ)
      WK2=WKN(IJ)
      THE2=THETA(IJ)
      PHASE(J)=PHASEL(IJ)+DPHASE
      PGC1(J)=PGC(IJ)
      GO TO 562
  561 XG(J)=XX(III)
      YG(J)=YY(III)+(J-1)*DRHO*IDIRC
      GC2=CG(III)
      WK2=WKN(III)
      THE2=THETA(III)
      PHASE(J)=PHASEL(III)+(J-1)*DRHO*BETA*IDIRC
      PGC1(J)=PGC(III)
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      GO TO 562
  563 IF(I .NE. 1) GO TO 564
      XG(J)=XX(IJ)
      YG(J)=YY(IJ)
      GC2=CG(IJ)
      WK2=WKN(IJ)
      THE2=THETA(IJ)
      PHASE(J)=PHASEL(IJ)
      PGC1(J)=PGC(IJ)
      GO TO 562
  564 DX=XG(1)-XOLD(1)
      DY=YG(1)-YOLD(1)
      XG(J)=XOLD(J)+DX
      YG(J)=YOLD(J)+DY
      DO 566 IJK=NNN-M+1,NNN+N-1
      IJK1=IJK+1
      IF(XX(IJK) .LE. XG(J) .AND. XX(IJK1) .GE. XG(J)) GO TO 567
      GO TO 566
  567 RATIO=(XX(IJK1)-XG(J))/(XX(IJK1)-XX(IJK))
      YTEMP=YY(IJK1)-RATIO*(YY(IJK1)-YY(IJK))
      GC2=CG(IJK1)-RATIO*(CG(IJK1)-CG(IJK))
      WK2=WKN(IJK1)-RATIO*(WKN(IJK1)-WKN(IJK))
      THE2=THETA(IJK1)-RATIO*(THETA(IJK1)-THETA(IJK))
      PHASE(J)=PHASEL(IJK1)-RATIO*(PHASEL(IJK1)-PHASEL(IJK))
     & +(YG(J)-YTEMP)*BETA
      PGC1(J)=PGC(IJK)-RATIO*(PGC(IJK1)-PGC(IJK))
      GO TO 562
  566 CONTINUE
C
C THIS SEGMENT IS TO DETERMINE WHETHER BREAKWATER IS PRESENT IN THE
C COMPUTATIONAL LINE OR NOT. IF IT IS PRESENT, DETERMINE WHICH POINT
C WILL BE USED AS SILID BOUNDARY AND ASSIGN VALUES TO THE MATRIX FOR
C 3 DIFFERENT DOMAIN CONDITIONS,I.E. EXPANDED, SHRUNK, OR UNCHANGED.
C
  562 IF(IBKWTR .EQ. 0) GO TO 551
      IF(J .EQ. 1) GO TO 551
      IF(IDM .GE. IBKWTR) GO TO 574
      DO 550 IK=1,IBKWTR
      IF(IBK(IK) .NE. 0)GO TO 550
      IK1=IBKWPT(IK)-1
      DO 552 IB=1,IK1
      IB1=IB+1
      CALL CROSS(XBW(IK,IB),YBW(IK,IB),XBW(IK,IB1),YBW(IK,IB1),
     & XG(J-1),YG(J-1),XG(J),YG(J),INTCON,XINT,YINT)
      IF(INTCON .EQ. 1) GO TO 553
  552 CONTINUE
  550 CONTINUE
  574 IDN=0
      GO TO 551
  553 IDM=IDM+1
      IBK(IK)=1
      IKK=IK
      THEB=ATAN2((YBW(IK,IB)-YBW(IK,IB1)),(XBW(IK,IB)-XBW(IK,IB1)))
      TNB=TAN(THEB)
      TNT=TAN(THE2)
      IF(IBATCH .NE. 2) WRITE(6,575)IK,THEB
  575 FORMAT(20X,'ENCOUNTERED BRKWTR NO. ',I2,5X,'BRKWTR ANGLE ',F10.6)
      DL1=SQRT((XINT-XG(J-1))**2+(YINT-YG(J-1))**2)
      DL2=SQRT((XINT-XG(J))**2+(YINT-YG(J))**2)
      IF(IOPTCO.EQ.0)CB=(0.,1.)*BETA*(TNB/TNT+1.)/(-TNT*TNB+1.)*IDIRC
```

```
      IF(IOPTCO.EQ.1)CB=(0.,1.)*WK2*SIN(THE2+THEB)/COS(ALPHA+THEB)*IDIRC
      IF(IOPTCO.EQ.2)CB=(0.,1.)*WK2*SIN(THE2+THEB)/COS(THEB)*IDIRC
      NUW(IK)=J-1
      DL=SQRT((XG(J)-XG(J-1))**2+(YG(J)-YG(J-1))**2)
      DL1=DL1/DL*DRHO
      DL2=DL2/DL*DRHO
      CD1=2.*DL1+DRHO+CB*DL1*DRHO
      C5(IK)=(4.*DL1-2.*CB*DRHO**2)/CD1
      C6(IK)=(DRHO-2.*DL1+CB*DL1*DRHO)/CD1
      CD2=DRHO+2.*DL2-CB*DRHO*DL2
      C7(IK)=(4.*DL2+2.*DRHO**2*CB)/CD2
      C8(IK)=(DRHO-2.*DL2-CB*DRHO*DL2)/CD2
      CD3=DRHO+DL1+CB*DRHO*DL1
      C9(IK)=(2.*DL1-4.*CB*DRHO**2)/CD3
      C10(IK)=(DRHO-DL1+CB*DRHO*DL1)/CD3
      CD4=DRHO+DL2-DRHO*DL2*CB
      C11(IK)=(2.*DL2+4.*CB*DRHO**2)/CD4
      C12(IK)=(DRHO-DL2-DRHO*DL2*CB)/CD4
      IDN=1
  551 XNEW(J)=XG(J)
      YNEW(J)=YG(J)
      AMPLT(J)=SQRT(CGDEEP/GC2*ABS(COS(ALPHA)/COS(THE2)))
      AM2(J)=AMPLT(J)
      IF(J .EQ. 1) THE1=THE2
C
C IF PHASE LINE IS OUTSIDE OF NEAR FIELD SET VV=0
C
      IF(XG(J).LE.XUB .OR. XG(J).GE.XLB .OR. YG(J).LE.YLB
     &   .OR. YG(J).GE.YRB) GO TO 570
C
C INTERPOLATE DEPTH FROM FOUR SURROUNDING POINTS AND THEN GET
C WAVE DATA (ACTUAL TOPOGRAPHY)
C
      CALL DEPINP(IX,IX1,IY,IY1,XG(J),YG(J),D2,UX,VY,DIVU)
      CALL WAVENO(D2,WKT,GCT,PGCT,IDEPTH)
      PGC1(J)=PGCT
      IF(IDEPTH.NE.-1) GO TO 576
      IF(IBATCH .NE. 2) WRITE(6,565)XG(J),YG(J)
  565 FORMAT(' REACHED DRY LAND AT ( ',F12.3,' , ',F12.3,' )')
      GO TO 760
  570 WKT=WK2
      D2=DEPM(IJ)
      UX=0.
      VY=0.
      DIVU=0.
C
C VO = K SQUARED - K HAT SQUARED;  NOTE: WK2 IS BACKGROUND WAVE NUMBER,
C      WKT IS ACTUAL WAVENUMBER, THEREFORE BELOW IS -VO.
C V1 = TERMS OF EFFECTS OF CURRENT ON WAVES
C V2 = TERM OF ENERGY DISSIPATION DUE TO BREAKING
C V3 = TERM OF ENERGY DISSIPATION DUE TO BOTTOM FRICTION
C US = TERM OF CURRENT EFFECTS ON WAVE NO. IN MARCHING DIRECTION
C UN = TERM OF CURRENT EFFECTS ON WAVE NO. IN TRANSVERSE DIRECTION
C DIVU = DIVERGENCE OF CURRENT VELOCITY
C WK2U+WK2V =INNER PRODUCT OF WK HAT AND CURRENT
C
  576 US=0.
      UN=0.
      V1=0.
      IF(ICURRN .EQ. 0) GO TO 577
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      IF(IOPTCO .EQ. 0) THEU=THE2
      IF(IOPTCO .EQ. 1) THEU=ALPHA
      IF(IOPTCO .EQ. 2) THEU=0.
      COSTHE=COS(THEU)
      SINTHE=SIN(THEU)
      OMEGD2=OMEGA/G/D2
      US=-(UX*COSTHE-VY*SINTHE)*OMEGD2
      UN=IDIRC*(UX*SINTHE+VY*COSTHE)*OMEGD2
      COSTH2=COS(THE2)
      SINTH2=SIN(THE2)
      WK2U=-UX*COSTH2*WK2
      WK2V=VY*SINTH2*WK2
      V1=((0.,1.0)*DIVU-2.*(WK2U+WK2V))*OMEGD2
      AMPLT(J)=AMPLT(J)*(1.-(WK2U+WK2V)/OMEGA)
  577 V2=0.
      IF(IBREAK .EQ. 0) GO TO 578
      ADRAT=CABS(FO(J))*AMPLT(J)*AO/D2
      IF(ADRAT .LT. 0.2) GO TO 578
      IF(ADRAT .LE. 0.4 .OR. IBROKN(J) .EQ. 0)GO TO 578
      V2=(0.0,1.0)*0.15*WK2/D2*(1.-0.16/4./ADRAT)
  578 V3=0.
      IF(IFRCT .EQ. 0) GO TO 580
      IF(XG(J) .GT. XDAMP) GO TO 580
      WKTH=WKT*D2
      V3=16./3./PAI*FRCT*WKT**3/(2.*WKTH+SINH(2.*WKTH))/SINH(WKTH)
     &  *CABS(FO(J))*AMPLT(J)*AO*(0.0,1.0)
  580 VO=WKT**2-WK2**2
      VV=VO+V1+V2+V3
      AA1=4./(AM2(J)+AM1(J))*(AM2(J)-AM1(J))/DSIG
      AA2=2./(PGC1(J)+PGCO(J))*(PGC1(J)-PGCO(J))/DSIG
      IF(J .EQ. 1 .OR. J .EQ. N) GO TO 571
      IF(IDN .NE. 0) GO TO 571
      BB1=(AM1(J+1)-AM1(J-1))/AM1(J)/2.
      BB2=(PGCO(J+1)-PGCO(J-1))/PGCO(J)/4.
      GO TO 573
  571 BB1=0.
      BB2=0.
  573 IF(IOPTCO .NE. 0) GO TO 581
      COST=COS(THE2)
      SINT=SIN(THE2)
      DTHE=(THE2-THE1)/SIN(THE1+THE2)+BB1+BB2+(0.,1.)*UN*COST*DRHO
      C4=((0.0,2.0)*(ABS(BETA)+US*SINT)+AA1+AA2)/GAMA/W/TAN(THE2)**2
      C1=2.-C4-VV*DSIG/GAMA*COST**2
      C3=2.*C2+C4-VV*DSIG/GAMA*C2*COST**2
      GO TO 586
  581 IF(IOPTCO .NE. 1) GO TO 582
      THE2=ALPHA-THE2
      DTHE=(0.0,1.0)*(WK2*SIN(THE2)+UN)*DRHO+BB1+BB2
      C4=((0.0,2.0)*(WK2*COS(THE2)+US)+AA1+AA2)/GAMA/W
      C1=2.-C4-VV*DSIG/GAMA
      C3=2.*C2+C4-VV*DSIG/GAMA*C2
      GO TO 586
  582 DTHE=(0.0,1.0)*(WK2*SIN(THE2)*IDIRC+UN)*DRHO+BB2
      C4=((0.0,2.0)*(WK2*COS(THE2)+US)+AA1+AA2)/GAMA/W
      C1=2.-C4-VV*DSIG/GAMA
      C3=2.*C2+C4-VV*DSIG/GAMA*C2
C
C CHECK FOR FIRST ROW OF MATRIX
C
  586 IF(J .EQ. 1) GO TO 590
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C
C CHECK FOR LAST ROW OF MATRIX
C
      IF(J .EQ. N) GO TO 600
      IF(IDN .NE. 0) GO TO 602
C
C FORM MIDDLE ROWS OF MATRIX
C
      A1(J)=-1.+DTHE
      A2(J)=C1
      A3(J)=-1.-DTHE
      B(J)=C2*(1.+DTHE)*FO(J+1)-C3*FO(J)+C2*(1.-DTHE)*FO(J-1)
C
C A SPECIAL CASE WHEN BREAKWATER IS ENCOUNTERED
C
      IF(NUW(IKK).LT.NUW1(IKK).AND.J.EQ.(NUW(IKK)+2)) B(J)=
     & (C2*(1.-DTHE)*C70(IKK)-C3)*FO(J)+(C2*(1.-DTHE)*C80(IKK)+
     & C2*(1.+DTHE))*FO(J+1)
      GO TO 620
C
C FIRST ROW OF MATRIX
C
  590 IF(IOPTBU .EQ. 0) GO TO 591
      A1(J)=0.
      A2(J)=C1
      A3(J)=-2.
      B(J)=2.*C2*FO(J+1)-C3*FO(J)
      GO TO 620
  591 A1(J)=0.
      A2(J)=C1
      A3(J)=-1.-DTHE
      B(J)=C2*(1.+DTHE)*FO(J+1)-C3*FO(J)+(C2+1.)*(1.-DTHE)
      GO TO 620
C
C LAST ROW OF MATRIX
C
  600 IF(IOPTBD .EQ. 0) GO TO 601
      A1(J)=-2.
      A2(J)=C1
      A3(J)=0.
      B(J)=2.*C2*FO(J-1)-C3*FO(J)
      GO TO 620
  601 A1(J)=-1.+DTHE
      A2(J)=C1
      A3(J)=0.
      B(J)=C2*(1.-DTHE)*FO(J-1)-C3*FO(J)+(C2+1.)*(1.+DTHE)
      GO TO 620
C
C THIS SEGMENT IS FOR A SOLID BOUNDARY WHEN BREAKWATER IS ENCOUNTERED
C
  602 DTHE=DTHE-BB1-BB2
      A1(J-1)=-1+DTHE+(-1.-DTHE)*C6(IK)
      A2(J-1)=C1+(-1.-DTHE)*C5(IK)
      A3(J-1)=0.
      A1(J)=0.
      A2(J)=(-1.+DTHE)*C7(IK)+C1
      A3(J)=(-1.+DTHE)*C8(IK)+(-1.-DTHE)
      IF(NUW(IK).NE. 0 .AND. NUW1(IK) .NE. 0)GO TO 603
      B(J-1)=C2*(1.-DTHE)*FO(J-2)-C3*FO(J-1)+C2*(1.+DTHE)*FO(J)
      B(J)=C2*(1.-DTHE)*FO(J-1)-C3*FO(J)+C2*(1.+DTHE)*FO(J+1)
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      GO TO 620
  603 B(J-1)=(C2*(1.-DTHE)+C2*(1.+DTHE)*C60(IK))*FO(J-2)+(-C3+
     & C2*(1.+DTHE)*C50(IK))*FO(J-1)
      B(J)=(C2*(1.-DTHE)*C70(IK)-C3)*FO(J)+(C2*(1.-DTHE)*C80(IK)+
     & C2*(1.+DTHE))*FO(J+1)
      IF(NUW(IK) .EQ. NUW1(IK)) GO TO 620
      B(J-1)=C2*(1.-DTHE)*FO(J-2)-C3*FO(J-1)+C2*(1.+DTHE)*FO(J)
C      B(J)=(C2*(1.-DTHE)*C110(IK)-C3*C70(IK)+C2*(1.+DTHE))*FO(J+1)-
C     & C3*C80(IK)*FO(J+2)+(C2*(1.-DTHE)+C120(IK))*FO(J+3)
      B(J)=((2.*C2*(1.-DTHE)-C3)*C70(IK)+2.*C2*DTHE)*FO(J+1)+
     & C80(IK)*(2.*C2*(1.-DTHE)-C3)*FO(J+2)
      IF(NUW(IK) .LT. NUW1(IK)) GO TO 620
      B(J-2)=(C2*(1.-DTHE)+C60(IK)*C2*(1.+DTHE))*FO(J-3)+(-C3+C2*
     & (1.+DTHE)*C50(IK))*FO(J-2)
C      B(J-1)=(C2*(1.-DTHE)-C3*C50(IK)+C2*(1.+DTHE)*C90(IK))*FO(J-2)-
C     & C3*C60(IK)*FO(J-3)+(C2*(1.+DTHE)*C100(IK))*FO(J-4)
      B(J-1)=(-2.*C2*DTHE+(-C3+2.*C2*(1.+DTHE))*C50(IK))*FO(J-2)+
     & (-C3+2.*C2*(1.+DTHE))*C60(IK)*FO(J-3)
      B(J)=C2*(1.-DTHE)*FO(J-1)-C3*FO(J)+C2*(1.+DTHE)*FO(J+1)
  620 THE1=THE2
C
C STORE DEPTH DATA FOR LATER USE WITH WAVE BREAKING CRITERIA
C
      DNODE(J)=D2
  630 CONTINUE
C
C NOTE: ALL THE TERMS ON THE RIGHT HAND SIDE OF EQN. 5.2.16 HAVE BEEN
C INCORPORATED INTO 'B' BEFORE IT IS SENT TO SUBROUTINE SOLVE
C ALSO: ARRAY FN CONTAINS THE VALUES OF THE DIFFRACTION FACTOR AT
C EACH NODE IN THE NEXT ROW WHEN IT IS RETURNED FROM SOLVE.
C
      CALL SOLVE(N,A1,A2,A3,B,FN)
  657 FORMAT(' I= ',I4,'  Re(F(I))= ',E12.6,'  Im(F(I))= ',
     *  E12.6)
C
C AMPRD =  AMPLITUDE CALCULATED
C
      DO 700 K=1,N
      AMPRD(K)=AMPLT(K)*FN(K)
C
C SEE EQN 14 FROM JGR ARTICLE CALCULATE CORRECTION DUE TO DIFFRACTION
C
      ASN(K)=ATAN2( AIMAG(AMPRD(K)),REAL(AMPRD(K)))
C
C ADD S hat TO PHASE OF FN (CORRECTION) TO FIND S actual
C
      ASN(K)=ASN(K)+PHASE(K)
      ARN(K)=CABS(AMPRD(K))
C
C CHECK FOR WAVE BREAKING
C
      IF(IBREAK.EQ.0) GO TO 700
      IF((ARN(K)*A0/DNODE(K)).LE.0.4) GO TO 700
      IBROKN(K)=1
  700 CONTINUE
C
C THE RESULTS  WILL BE INTERPOLATED EVERY (IP) STEPS. EX. IF IP=5 THEN
C INTRSC IS CALLED AFTER CALCULATIONS ARE DONE FOR I=1,6,11, ETC.
C OUTPUT THE PHASE LINE WHICH HAS BEEN CONSTRUCTED
C
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      INT=(I-1)-((I-1)/IP)*IP
      IF(INT .NE. 0) GO TO 702
      DO 749 JJJ=1,NUMSEC
      CALL INTRSC(N,XUB,XNEW,YNEW,XOLD,YOLD,X11(JJJ),Y11(JJJ),
     * X21(JJJ),Y21(JJJ),ARN,ARO,ASN,ASO,IUNIT(JJJ),NUW,NUW1,IBKWTR,
     * IOPTCO)
  749 CONTINUE
  702 IF(IBKWTR .EQ. 0)GO TO 692
      DO 691 K=1,IBKWTR
      NUW1(K)=NUW(K)
      IBK(K)=0
      C50(K)=C5(K)
      C60(K)=C6(K)
      C70(K)=C7(K)
      C80(K)=C8(K)
      C90(K)=C9(K)
      C100(K)=C10(K)
      C110(K)=C11(K)
      C120(K)=C12(K)
  691 CONTINUE
  692 ICOUNT = ICOUNT + 1
  750 CONTINUE
  760 IF(IBATCH .NE. 2) WRITE(6,770) ICOUNT
  770 FORMAT(' ICOUNT = ',I6)
C
C DUMP VALUES TO INDICATES THE END OF COMPUTATIONS
C
  775 DUM1=-99.0
      DUM2=-99.
      DUM3=-99.0
      DO 790 I=1,NUMSEC
      IUNIT1=I+20
      WRITE(IUNIT1,780)DUM1,DUM2,DUM3
  790 CONTINUE
  780 FORMAT(3F16.5)
      RETURN
      END
```

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C
C
      SUBROUTINE INTRSC(N,XBASE,XN,YN,XOLD,YOLD,X1,Y1,X2,Y2,AMPLT,AMPOLD
     & ,PHASE,PHOLD,IUNIT,NW,NW1,IBKWTR,IOPTCO)
C
C SUBROUTINE TO FIND INTERPOLATED VALUES FOR PHASE AND AMPLITUDE ALONG
C SPECIFIED CROSS-SECTIONS.  THE INTERPOLATION IS LINEAR BETWEEN THE
C UNEVENLY SPACED POINTS AT WHICH THE PROGRAM SOLVES FOR THE UNKNOWNS.
C IN EACH CALL TO THIS SUBROUTINE THE ENTIRE PHASELINE IS CHECKED
C AGAINST ONE PROFILE.
C  DEFINITION OF VARIABLES:
C    N= NUMBER OF NODES PRESENTLY ON PHASE LINE
C    XBASE= X-COORDINATE OF BASE LINE (XUB)
C    XN,YN= ARRAYS WHICH STORE THE X AND Y LOCATIONS OF THE NODES ON THE
C           PRESENT PHASELINE
C    XA,YA,XB,YB= THE TWO NODES ON THE COMPUTATIONAL LINE WHICH ARE BEING
C           CHECKED AT ANY GIVEN MARCHED STEP.
C    XOLD,YOLD= ARRAYS WHICH STORE THE X AND Y LOCATIONS OF THE NODES ON
C           THE COMPUTATIONAL LINE AT PREVIOUS STEP.
C    X1,Y1= STORE LOCATION OF THE FIRST POINT WHICH DEFINES THE PROFILE.
C    X2,Y2= STORE LOCATION OF THE SECOND ENDPOINT OF THE PROFILE.
C    AMPLT= AMPLITUDES AT THE NODES OF THE PRESENT COMPUTATIONAL LINE.
C    AMPOLD= AMPLITUDES AT THE NODES OF THE COMPUTATIONAL LINE AT THE
C           PREVIOUS STEP.
C    PHASE= VALUES OF THE PHASE ANGLE AT THE NODES OF PRESENT LINE
C    PHOLD= VALUES OF THE PHASE ANGLE AT THE NODES AT PREVIOUS STEP.
C    IUNIT= NUMBER OF THE LOGICAL UNIT TO WRITE THE RESULTS TO
C    NW= CURRENT NO. OF POINTS AT UPWAVE SIDE OF BREAKWATER
C    NW1= PREVIOUS NO. OF POINTS AT UPWAVE SIDE OF BREAKWATER
C
      DIMENSION XN(N),YN(N),AMPLT(N),XOLD(N),YOLD(N),AMPOLD(N)
      DIMENSION PHASE(N),PHOLD(N),NW(5),NW1(5)
      I=1
   10 I1=I+1
      IF(IBKWTR .EQ. 0) GO TO 11
      IF(I .EQ. NW(1) .OR. I .EQ. NW(2) .OR. I .EQ. NW(3) .OR.
     *   I .EQ. NW(4) .OR. I .EQ. NW(5)) GO TO 15
   11 CALL CROSS(X1,Y1,X2,Y2,XN(I),YN(I),XN(I1),YN(I1),ICON,XINT,YINT)
      IF(ICON.EQ.1) GO TO 40
   15 I=I+1
      IF(I.GE.N) GO TO 50
      GO TO 10
   40 D=((XN(I1)-XN(I))**2+(YN(I1)-YN(I))**2)**0.5
      D1=((XN(I1)-XINT)**2+(YN(I1)-YINT)**2)**0.5
      R=D1/D
      A=R*AMPLT(I)+(1.0-R)*AMPLT(I1)
      S=R*PHASE(I)+(1.0-R)*PHASE(I1)
      CALL CRSOUT(XINT,YINT,A,S,IUNIT)
      IF(IOPTCO .NE. 2)GO TO 50
      RETURN
   50 II=I
      IDD=0
      ID=1
      I=I1
      IF(I .GE. N) I=1
      IF(XOLD(I).LE. XBASE)RETURN
   60 IF(IBKWTR .EQ. 0) GO TO 61
      DO 62 IK=1,IBKWTR
      IF((NW(IK) .EQ. I .AND. NW(IK) .GT. NW1(IK)) .OR.
     & ((NW(IK)+1) .EQ. I .AND. NW(IK) .LT. NW1(IK))) GO TO 81
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   62 CONTINUE
   61 CALL CROSS(X1,Y1,X2,Y2,XN(I),YN(I),XOLD(I),YOLD(I),ICON,XINT,YINT)
      IF(ICON.NE.1) GO TO 81
      D=((XN(I)-XOLD(I))**2+(YN(I)-YOLD(I))**2)**0.5
      D1=((XN(I)-XINT)**2+(YN(I)-YINT)**2)**0.5
      R=D1/D
      A=R*AMPOLD(I)+(1.0-R)*AMPLT(I)
      S=R*PHOLD(I)+(1.0-R)*PHASE(I)
      CALL CRSOUT(XINT,YINT,A,S,IUNIT)
      IDD=1
   81 IF(ID .EQ. -1) GO TO 120
   70 I=I+1
      ID=1
      IF(I.GT.N) GO TO 110
      GO TO 60
  110 IF(IDD .EQ. 1)RETURN
      I=II
  120 I=I-1
      ID=-1
      IF(I .LE. 0)RETURN
      GO TO 60
      END
C
C SUBROUTINE TO OUTPUT CROSSING DATA
C
      SUBROUTINE CRSOUT(X,Y,A,S,IUNIT)
      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
      CALL DEPINP(IX,IX1,IY,IY1,X,Y,DR,UX,VY,DIVU)
      IF(IUNIT.NE.21) GO TO 20
      IF(IBATCH .NE. 2) WRITE(6,10)X,Y,A,DR,S
   10 FORMAT(1X,'XP= ',F9.3,1X,'YP= ',F9.3,
     & ' AMPLITUDE= ',F7.3,' DEPTH= ',F8.3,' PHASE= ',F8.3)
   20 WRITE(IUNIT,21) X,Y,A,DR,S
   21 FORMAT(5F16.4)
      RETURN
      END
C
C SUBROUTINE FOR PROFILE INTERSECTION WITH LINE SEGMENT.
C
      SUBROUTINE CROSS(PX1,PY1,PX2,PY2,X1,Y1,X2,Y2,INTCON,XINT,YINT)
C
C  DEFINITION OF VARIABLES:
C    INPUT:  (PX1,PY1)=FIRST END-POINT DEFINING PROFILE
C            (PX2,PY2)=SECOND END-POINT DEFINING PROFILE
C            (X1,Y1)= FIRST ENDPOINT DEFINING SEGMENT
C            (X2,Y2)= SECOND ENDPOINT DEFINING SEGMENT
C    OUTPUT: INTCON="INTERSECTION CONDITION" : =0 FOR NO CROSSING WITHIN
C            SEGMENT;  =1 FOR CROSSING AT ONE POINT ON SEGMENT; =2 FOR
C            PARALLEL LINES, ie. CROSSING ON WHOLE LENGTH OF SEGMENT.
C            XINT,YINT=INTERSECTION OF THESE TWO LINES
C
      PXMAX=PX1
      PXMIN=PX2
      PYMAX=PY1
      PYMIN=PY2
      IF(PX1.GE.PX2) GO TO 30
      PXMAX=PX2
      PXMIN=PX1
   30 IF(PY1.GE.PY2) GO TO 40
      PYMAX=PY2
```

```
      PYMIN=PY1
C
C FIND IMPLICIT EQN. OF LINE DEFINED BY THE PROFILE. PC1x+PC2y+PC3=0
C
   40 PC1=PY2-PY1
      PC2=PX1-PX2
      PC3=PX2*PY1-PX1*PY2
C
C FIND IMPLICIT EQN. FOR SEGMENT
C
      C1=Y2-Y1
      C2=X1-X2
      C3=X2*Y1-X1*Y2
      A1=PC1*X1+PC2*Y1+PC3
      A2=PC1*X2+PC2*Y2+PC3
      IF(A1 .EQ. 0. .AND. A2 .EQ. 0.) GO TO 100
      IF((A1*A2) .GT. 0.) GO TO 50
      B1=C1*PX1+C2*PY1+C3
      B2=C1*PX2+C2*PY2+C3
      IF((B1*B2) .GT. 0.) GO TO 50
      DENOM=PC1*C2-C1*PC2
      XINT=(PC2*C3-C2*PC3)/DENOM
      YINT=(PC3*C1-C3*PC1)/DENOM
      INTCON=1
      RETURN
C
C INTERSECTION IS NOT WITHIN BOUNDS OF EITHER SEGMENT OR PROFILE.
C
   50 INTCON=0
      RETURN
C
C IF LINES OVERLAP, CHECK IF THEY OVERLAP ONLY PARTIALLY.
C
  100 XINT=X1
      YINT=Y1
      IF(X1.LT.PXMIN .OR. X1.GT.PXMAX) GO TO 70
      IF(Y1.LT.PYMIN .OR. Y1.GT.PYMAX) GO TO 70
      INTCON=1
      RETURN
C
C (X1,Y1) IS NOT ON PROFILE
C
   70 IF(X2.LT.PXMIN .OR. X2.GT.PXMAX) GO TO 80
      IF(Y2.LT.PYMIN .OR. Y2.GT.PYMAX) GO TO 80
      XINT=X2
      YINT=Y2
      INTCON=1
      RETURN
C
C (X2,Y2) IS NOT ON PROFILE
C
   80 INTCON=2
      RETURN
      END
C
C
      SUBROUTINE CURVIL(BETA,WK,THE,DG,DX,DY,IOPTCO)
      I=1
      DX=0.
      DY=0.
```

```
      EPSILN=0.05
      IF(BETA .LT. 0) I=-1
      THE=I*ASIN(ABS(BETA)/WK)
      IF(IOPTCO .NE. 0) RETURN
      IF(ABS(THE).LT.EPSILN) GO TO 10
      TANG=TAN(THE)
      CTANG=1./TANG
      DX=DG/(TANG+CTANG)
      DY=CTANG*DX
      RETURN
   10 DX=DG*SIN(THE)
      DY=DG*COS(THE)
      RETURN
      END
C
C
C SOLVE THE DISPERSION RELATION THROUGH AN ITERATIVE METHOD.
C  INPUT:    OMEGA= WAVE FREQUENCY; G= GRAVITY; D= DEPTH
C  RETURNED: WK= WAVE NUMBER; GC= GROUP VELOCITY; PGC=PC*GC
C            (PC= PHASE VELOCITY)
      SUBROUTINE WAVENO(D,WK,GC,PGC,IDEPTH)
      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
C
C SET INITIAL ESTIMATE OF WAVENUMBER
C
      IDEPTH = 1
      IF(D.LE.1E-11) GO TO 30
      WKD=SQRT(OMEGA**2/G*D)/D
      ITER=1
   10 WKH=WKD*D
      S1=OMEGA**2-G*WKD*TANH(WKH)
      S2=-G*(TANH(WKH)+WKH/COSH(WKH)**2)
C
C ESTIMATE RELATIVE ERROR
C
      ER=S1/S2
      WKD=WKD-ER
      ITER=ITER+1
C
C CHECK IF TOO MANY ITERATIONS
C
      IF(ITER .GE. 30) GO TO 20
C
C CHECK IF ERROR CRITERION IS SATISFIED
C
      IF(ABS(ER)/WKD .GE.1.E-6) GO TO 10
      WK=WKD
      PC=OMEGA/WK
      GC=PC*0.5*(1.+2.*WK*D/SINH(2.*WK*D))
      PGC=PC*GC
      RETURN
C
C USE SHALLOW WATER APPROXIMATION IF TOO MANY ITERATIONS
C
   20 GC=SQRT(G*D)
      WK=OMEGA/GC
      PGC=GC*GC
      RETURN
   30 IDEPTH= -1
      RETURN
```

```
      END
C
C TRIDIAGONAL MATRIX EQUATION SOLVER
C   [{A1} {A2} {A3}] {FN} = {B}
C  INPUT: N= DIMENSION OF THE MATRIX
C           = NUMBER OF NODES IN THE ROW TO BE SOLVED
C          A1,A2,A3 AND B
C  RETURNED: FN = DIFFRACTION FACTOR AT EACH NODE
C
      SUBROUTINE SOLVE(N,A1,A2,A3,B,FN)
      COMPLEX B(N),FN(N),A1(N),A2(N),A3(N)
C***********************************************************************
C     GAUSSIAN ELIMINATION WITHOUT PIVOTING
C***********************************************************************
      DO 10 I=2,N
      I1=I-1
      B(I)=B(I)-A1(I)*B(I1)/A2(I1)
      A2(I)=A2(I)-A1(I)*A3(I1)/A2(I1)
      A3(I)=A3(I)
      A1(I)=0.
   10 CONTINUE
      N1=N-1
C***********************************************************************
C     BACK SUBSTITUTION
C***********************************************************************
      FN(N)=B(N)/A2(N)
      DO 20 I=2,N
      J=N+1-I
      FN(J)=(B(J)-A3(J)*FN(J+1))/A2(J)
   20 CONTINUE
      RETURN
      END
C
C
C SUBROUTINE CUSPIP ( CUbic SPline InterPolation )
C  INPUT: MX,NY,X(just passed through),Y,D,S1,S2,DBASE
C  RETURNED: C
C  NOTE: THE ARRAY C CONTAINS THE COEFFICIENTS OF THE CUBIC EQUATION
C         USED IN A CUBIC SPLINE INTERPOLATION ALONG EACH LINEOF NODES
C
      SUBROUTINE CUSPIP(MX,NY,X,Y,D,C,S1,S2,DBASE,DC,TIDE)
      DIMENSION X(MX),Y(NY),D(134,133),C(4,134)
      MX1=MX-1
      NY1=NY-1
      C(1,1)=DBASE+TIDE
C
C LOOP TO VARY X-NODE
C
      DO 20 I=2,MX1
      SUM=0.
C
C LOOP TO VARY Y-NODE
C
      DO 10 J=3,NY1
      SUM=SUM+0.5*(D(I,J)+D(I,J-1))*(Y(J)-Y(J-1))
   10 CONTINUE
C
C C(1,I) CONTAINS THE WEIGHTED AVG. DEPTH ALONG NODE ROW I. (H bar)
C
      C(1,I)=SUM/(Y(NY1)-Y(2))
```

```
   20 CONTINUE
      C(1,MX)=DC+TIDE
      C(2,1)=S1
      C(2,MX)=S2
      CALL SPLINE(MX1,MX,X,C)
      CALL CALCCF(MX1,MX,X,C)
      RETURN
      END
C
C
C   INPUT: N,I,XI;  RETURNED: C
C
      SUBROUTINE SPLINE(N,I,XI,C)
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      DIMENSION XI(MX),C(4,134),D(134),DIAG(134)
      DIAG(1)=1.
      D(1)=0.
      NP1=I
C
C LOOP THROUGH X-VALUES TO COVER NEAR FIELD
C
      DO 10 M=2,NP1
      D(M)=XI(M)-XI(M-1)
C
C DIAG(M) CONTAINS THE AVG. SLOPE BETWEEN ROW (M) AND ROW (M-1).
C
      DIAG(M)=(C(1,M)-C(1,M-1))/D(M)
   10 CONTINUE
C
C AGAIN LOOP TO COVER NEAR FIELD
C
      DO 20 M=2,N
      C(2,M)=3.*(D(M)*DIAG(M+1)+D(M+1)*DIAG(M))
      DIAG(M)=2.*(D(M)+D(M+1))
   20 CONTINUE
C
C AGAIN LOOP TO COVER NEAR FIELD
C
      DO 30 M=2,N
      G=-D(M+1)/DIAG(M-1)
      DIAG(M)=DIAG(M)+G*D(M-1)
      C(2,M)=C(2,M)+G*C(2,M-1)
   30 CONTINUE
      NJ=NP1
C
C COMPLETE CALCULATION OF SECOND ROW OF ARRAY C
C
      DO 40 M=2,N
C
C THE VALUE OF NJ WILL VARY FROM MX-2 DOWN TO 2
C
      NJ=NJ-1
      C(2,NJ)=(C(2,NJ)-D(NJ)*C(2,NJ+1))/DIAG(NJ)
   40 CONTINUE
      RETURN
      END
C
C
C SUBROUTINE CALCCF  (CALCulate Cubic spline CoEfficients)
C  INPUT: N,MX,XI; RETURNED: C  (N MUST BE .LT. MX)
```

```
C
      SUBROUTINE CALCCF(N,MX,XI,C)
      DIMENSION XI(MX),C(4,134)
      DO 10 I=1,N
      DX=XI(I+1)-XI(I)
      DIVDF1=(C(1,I+1)-C(1,I))/DX
      DIVDF3=C(2,I)+C(2,I+1)-2.*DIVDF1
      C(3,I)=(DIVDF1-C(2,I)-DIVDF3)/DX
   10 C(4,I)=DIVDF3/DX/DX
      RETURN
      END
C
C
C FUNCTION PCUBIC   (Polynomial - CUBIC)
C  INPUT: XBAR; RETURNED: PCUBIC
C  NOTE: THIS FUNCTION ALWAYS RETURNS A DEPTH FOR BACKGROUND TOPOGRAPHY.
C
      FUNCTION PCUBIC(XBAR)
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      COMMON/CC/ C
      DIMENSION XI(134),C(4,134),YI(133),DEP(134,133)
      DIMENSION U(134,133),V(134,133)
      IF(IBACKD.EQ.1) GO TO 8
      IF(IBACKD.EQ.2) GO TO 6
C
C ALTERNATIVE CONSTANT SLOPE BACKGROUND FOR DEBUGGING
C
      PCUBIC=0.01*XBAR
      RETURN
C
C ALTERNATIVE: CUBIC LEAST-SQUARE FITS TO ALL INPUT DEPTHS FOR
C BACKGROUND TOPOGRAPHY
C
    6 X=XBAR
      PCUBIC=C(1,4)+C(2,4)*X+C(3,4)*X*X+C(4,4)*X*X*X
      RETURN
C
C ORIGINAL CUBIC SPLINE ALGORITHM
C
    8 I=1
      DX=XBAR-XI(I)
C
C SORT THROUGH ARRAY OF LOCATIONS XI(N) TO FIND THE NODE ROW NUMBERS
C (N) AND (N+1) WHICH ARE ON DIFFERENT SIDES OF X-LOCATION XBAR
C
      IF(DX) 10,40,30
C
C CHECK IF POINT IS ABOVE NEAR FIELD
C
   10 IF(I .EQ.1) GO TO 40
      I=I-1
      DX=XBAR-XI(I)
      IF(DX) 10,40,40
   20 I=I+1
      DX=DDX
C
C CHECK IF POINT IS BELOW NEAR FIELD
C
```

```
   30 IF(I .EQ. MX) GO TO 40
      DDX=XBAR-XI(I+1)
C
C LOOP UNTIL XI(I+1) > XBAR
C
      IF(DDX) 40,20,20
C
C NOTE: FORM OF F(x)= C(1,I) + C(2,I) x +C(3,I) x*x + C(4,I) x*x*x
C
   40 PCUBIC=C(1,I)+DX*(C(2,I)+DX*(C(3,I)+DX*C(4,I)))
      RETURN
      END
C
C
C SUBROUTINE DEPINP  (DEPth INterPolation)
C INPUT:
C  MX= NUMBER OF NODES IN X-DIRECTION (INCLUDES 1 ARTIFICIAL NODE).
C  NY= NUMBER OF NODES IN Y-DIRECTION (INCLUDES 2 ARTIFICIAL NODES).
C  IX= NUMBER OF X-LOCATION OF NODE AT WHICH TO START CHECKING
C      TO FIND THE NODES WHICH BRACKET THE POINT OF INTEREST.
C  IX1= IX+1
C  IY= NUMBER OF Y-LOCATION OF NODE AT WHICH TO START CHECKING
C      TO FIND THE NODES WHICH BRACKET THE POINT OF INTEREST.
C  IY1= IY+1
C  XI= ARRAY OF X-LOCATIONS OF GRID POINTS OF INPUT DEPTHS.
C  YI= ARRAY OF Y-LOCATIONS OF GRID POINTS OF INPUT DEPTHS.
C  DEP= ARRAY OF VALUES OF INPUT DEPTHS
C  X= X-LOCATION OF POINT OF INTEREST.
C  Y= Y-LOCATION OF POINT OF INTEREST.
C RETURNED:
C  DR= THE INTERPOLATED ACTUAL DEPTH AT THE POINT OF INTEREST -
C  UX= THE INTERPOLATED CURRENT COMPONENT IN X-DIR.
C  VY= THE INTERPOLATED CURRENT COMPONENT IN Y-DIR.
C  DIVU= DIVERGENCE OF CURRENT VECTOR
C
      SUBROUTINE DEPINP(IX,IX1,IY,IY1,X,Y,DR,UX,VY,DIVU)
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      COMMON/CC/ C
      DIMENSION XI(134),YI(133),DEP(134,133),TEMP(16),XGRID(4)
      DIMENSION YGRID(4),C(4,134),U(134,133),V(134,133),B(6)
      UX=0.
      VY=0.
      DIVU=0.
      IF(IREALD.GT.0) GO TO 5
C
C ALTERNATE SLOPE FOR DEBUGGING
C
      DR=0.01*X
      RETURN
    5 IX=1
      IX1=2
      IY=1
      IY1=2
      MX1=MX-1
      NY1=NY-1
   10 IF(X .LT. XI(IX) .AND. X .LT. XI(IX1)) GO TO 40
   20 IF(X .GT. XI(IX) .AND. X .GT. XI(IX1)) GO TO 30
C
```

```
C IF X NODES LOCATED THEN LOOK FOR Y NODES
C
      IF(X .GE. XI(IX) .AND. X .LE. XI(IX1)) GO TO 50
   30 IX=IX+1
      IX1=IX+1
      IF(IX .EQ. MX1) GO TO 100
      GO TO 20
   40 IX1=IX
      IX=IX1-1
      IF(IX .EQ. 0) GO TO 100
      GO TO 10
   50 IF(Y .LT. YI(IY) .AND. Y .LT. YI(IY1)) GO TO 80
   60 IF(Y .GT. YI(IY) .AND. Y .GT. YI(IY1)) GO TO 70
C
C IF Y NODES LOCATED THEN DO INTERPOLATION
C
      IF(Y .GE. YI(IY) .AND. Y .LE. YI(IY1)) GO TO 90
   70 IY=IY+1
      IY1=IY+1
      IF(IY .EQ. NY1) GO TO 100
      GO TO 60
   80 IY1=IY
      IY=IY1-1
      IF(IY .EQ. 1) GO TO 100
      GO TO 50
   90 IF(IREALD .GT. 1) GO TO 140
      RH=XI(IX1)-XI(IX)
      RK=YI(IY1)-YI(IY)
C
C FRACTION AWAY FROM NODE IX
C
      P=(X-XI(IX))/RH
C
C FRACTION AWAY FROM NODE IY
C
      Q=(Y-YI(IY))/RK
C
C FRACTION AWAY FROM NODE IX+1
C
      P1=1.-P
C
C FRACTION AWAY FROM NODE IY+1
C
      Q1=1.-Q
C
C DIRECT WEIGHTING BY DISTANCE FROM NODES WHERE DEPTHS ARE KNOWN
C
      DR=P1*Q1*DEP(IX,IY)+P*Q1*DEP(IX1,IY)+Q*P1*DEP(IX,IY1)+
     *   P*Q*DEP(IX1,IY1)
      IF(ICURRN .EQ. 0) RETURN
      UX=P1*Q1*U(IX,IY)+P*Q1*U(IX1,IY)+Q*P1*U(IX,IY1)+
     *   P*Q*U(IX1,IY1)
      VY=P1*Q1*V(IX,IY)+P*Q1*V(IX1,IY)+Q*P1*V(IX,IY1)+
     *   P*Q*V(IX1,IY1)
      DIVU=(Q1*(-U(IX,IY)+U(IX1,IY))+Q*(-U(IX,IY1)+U(IX1,IY1)))/RH
     * +(P1*(-V(IX,IY)+V(IX,IY1))+P*(-V(IX1,IY)+V(IX1,IY1)))/RK
      RETURN
  100 IF(IBATCH .NE. 2) WRITE(6,110)
  110 FORMAT(' OUTSIDE NEAR FIELD - USING BACKGROUND DEPTH')
      DR=PCUBIC(X)
```

```
      RETURN
  140 IX2=IX1+1
      IY2=IY1+1
      IX0=IX-1
      IY0=IY-1
      IF(IX0 .NE. 0) GO TO 160
      IX0=1
      IX=2
      IX1=3
      IX2=4
  160 XGRID(1)=XI(IX0)
      XGRID(2)=XI(IX)
      XGRID(3)=XI(IX1)
      XGRID(4)=XI(IX2)
      YGRID(1)=YI(IY0)
      YGRID(2)=YI(IY)
      YGRID(3)=YI(IY1)
      YGRID(4)=YI(IY2)
C
C SUBROUTINE FOR CUBIC SPLINE DEPTH INTERPOLATION
C
      IF(IREALD.GT.3) GO TO 130
      CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,DEP,TEMP)
      CALL CUBDEP(IREALD,TEMP,XGRID,YGRID,X,Y,DR,DRDX)
      IF(ICURRN .EQ. 0) RETURN
      CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,U,TEMP)
      CALL CUBDEP(2,TEMP,XGRID,YGRID,X,Y,UX,DUDX)
      CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,V,TEMP)
      CALL CUBDEP(3,TEMP,XGRID,YGRID,X,Y,VY,DVDY)
      DIVU=DUDX+DVDY
      RETURN
C
C FOR LEAST SQUARES SURFACE FIT ON THE SIXTEEN DATA POINTS.
C G(X,Y)= A0 + A1 X + A2 Y + A3 X Y + A4 X**2 + A5 Y**2
C
 130  CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,DEP,TEMP)
      CALL LSTSQR(TEMP,XGRID,YGRID,X,Y,DR,B)
      IF(ICURRN .EQ. 0) RETURN
      CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,DEP,TEMP)
      CALL LSTSQR(TEMP,XGRID,YGRID,X,Y,UX,B)
      DIVU=B(2)+B(4)*Y+2.*B(5)*X
      CALL TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,DEP,TEMP)
      CALL LSTSQR(TEMP,XGRID,YGRID,X,Y,VY,B)
      DIVU=DIVU+B(3)+B(4)*X+2.*B(6)*Y
      RETURN
      END
C
C STORE QUANTITIES FOR LOCAL TRANSFORMATION IN 16-POINT LSTSQR
C
      SUBROUTINE TRALOC(IX0,IX,IX1,IX2,IY0,IY,IY1,IY2,FF,TEMP)
      DIMENSION FF(134,133),TEMP(16)
      TEMP(1)= FF(IX0,IY0)
      TEMP(2)= FF(IX0,IY)
      TEMP(3)= FF(IX0,IY1)
      TEMP(4)= FF(IX0,IY2)
      TEMP(5)= FF(IX,IY0)
      TEMP(6)= FF(IX,IY)
      TEMP(7)= FF(IX,IY1)
      TEMP(8)= FF(IX,IY2)
      TEMP(9)= FF(IX1,IY0)
```

```
      TEMP(10)= FF(IX1,IY)
      TEMP(11)= FF(IX1,IY1)
      TEMP(12)= FF(IX1,IY2)
      TEMP(13)= FF(IX2,IY0)
      TEMP(14)= FF(IX2,IY)
      TEMP(15)= FF(IX2,IY1)
      TEMP(16)= FF(IX2,IY2)
      RETURN
      END
C
C
      SUBROUTINE CUBDEP(IFLAG,DEPTH,XGRID,YGRID,X,Y,DR,DRDX)
      DIMENSION DEPTH(16),XGRID(4),YGRID(4),DINTRP(4)
      IF(IFLAG.EQ.3) GO TO 10
C
C DO CUBIC SPLINE ACROSS EACH X-ROW (IFLAG=2). I.E. SPLINE ACROSS ROWS TO
C INTERPLOATE QUANTITY AT THE INTERSECTION OF EACH ROW WITH THE DESIRED
C Y AND THEN SPLINE DOWN THESE FOUR VALUES TO YIELD AN INTERPOLATED
C QUANTITY AT X.
C
      CALL SPL4PT(Y,YGRID,DEPTH(1),DEPTH(2),DEPTH(3),DEPTH(4),DINTRP(1)
     *   ,DFDX)
      CALL SPL4PT(Y,YGRID,DEPTH(5),DEPTH(6),DEPTH(7),DEPTH(8),DINTRP(2)
     *   ,DFDX)
      CALL SPL4PT(Y,YGRID,DEPTH(9),DEPTH(10),DEPTH(11),DEPTH(12),
     *   DINTRP(3),DFDX)
      CALL SPL4PT(Y,YGRID,DEPTH(13),DEPTH(14),DEPTH(15),DEPTH(16),
     *   DINTRP(4),DFDX)
      CALL SPL4PT(X,XGRID,DINTRP(1),DINTRP(2),DINTRP(3),DINTRP(4),DR,
     *   DRDX)
      RETURN
C
C DO CUBIC SPLINE DOWN EACH Y-COLUMN FIRST (IFLAG=3)
C
   10 CALL SPL4PT(X,XGRID,DEPTH(1),DEPTH(5),DEPTH(9),DEPTH(13),DINTRP(1)
     *   ,DFDX)
      CALL SPL4PT(X,XGRID,DEPTH(2),DEPTH(6),DEPTH(10),DEPTH(14),
     *   DINTRP(2),DFDX)
      CALL SPL4PT(X,XGRID,DEPTH(3),DEPTH(7),DEPTH(11),DEPTH(15),
     *   DINTRP(3),DFDX)
      CALL SPL4PT(X,XGRID,DEPTH(4),DEPTH(8),DEPTH(12),DEPTH(16),
     *   DINTRP(4),DFDX)
C
C THEN ACROSS ROW
C
      CALL SPL4PT(Y,YGRID,DINTRP(1),DINTRP(2),DINTRP(3),
     * DINTRP(4),DR,DRDX)
      RETURN
      END
C
C
      SUBROUTINE SPL4PT(X,XGRID,D1,D2,D3,D4,FX,DFDX)
      DIMENSION XGRID(4),DX(3),A(2,2),B(2)
      IF(D1.EQ.D2 .AND. D2.EQ.D3 .AND. D3.EQ.D4) GO TO 99
      DX(1)= XGRID(2)-XGRID(1)
      DX(2)= XGRID(3)-XGRID(2)
      DX(3)= XGRID(4)-XGRID(3)
      A(1,1)= 2.*(XGRID(3)-XGRID(1))/DX(2)
      A(1,2)= 1.0
      B(1)= 6.0*((D3-D2)/(DX(2)*DX(2))-(D2-D1)/(DX(2)*DX(1)))
```

```
      A(2,1)=DX(2)/DX(3)
      A(2,2)= 2.*(XGRID(4)-XGRID(2))/DX(3)
      B(2)=6.*((D4-D3)/(DX(3)*DX(3))-(D3-D2)/(DX(3)*DX(2)))
      CALL SOLVE2(A,B)
      FX=B(1)/6.0*((XGRID(3)-X)**3/DX(2)-DX(2)*(XGRID(3)-X))
      FX=FX+B(2)/6.0*((X-XGRID(2))**3/DX(2)-DX(2)*(X-XGRID(2)))
      FX=FX+D2*(XGRID(3)-X)/DX(2)+D3*(X-XGRID(2))/DX(2)
      DFDX=B(1)/6.*(3.*(XGRID(3)-X)**2/DX(2)+DX(2))
     * +B(2)/6.*(3.*(X-XGRID(2))**2/DX(2)-DX(2))+(D3-D2)/DX(2)
      RETURN
   99 FX=D1
      DFDX=0.
      RETURN
      END
C
C
      SUBROUTINE SOLVE2(A,B)
      DIMENSION A(2,2), B(2)
      PIV=A(1,1)
      A(1,1)=1.0
      A(1,2)=A(1,2)/PIV
      B(1)= B(1)/PIV
      RMULT=A(2,1)
      A(2,1)=0.0
      A(2,2)=A(2,2)-RMULT*A(1,2)
      B(2)=B(2)-RMULT*B(1)
      DIV=A(2,2)
      A(2,2)=1.0
      B(2)= B(2)/DIV
      RMULT=A(1,2)
      A(1,2)=0.0
      B(1)=B(1)-RMULT*B(2)
      RETURN
      END
C
C
      SUBROUTINE LSTSQR(DEPTH,XGRID,YGRID,X,Y,DR,B)
      DIMENSION XGRID(4),YGRID(4),DEPTH(16),A(6,6),B(6)
      COMMON/DI/IBACKD,IREALD,IBREA,ICURRN
      N=6
      CALL MAKEQN(A,B,XGRID,YGRID,DEPTH)
      CALL GJSOLV(A,B,N)
      DR=B(1)+B(2)*X+B(3)*Y+B(4)*X*Y+B(5)*X*X+B(6)*Y*Y
      RETURN
      END
C
C
      SUBROUTINE MAKEQN(A,B,X,Y,D)
      DIMENSION X(4),Y(4),D(16),A(6,6),B(6)
      A(1,1)=16.0
      SX=0.0
      SY=0.0
      SXY=0.0
      SXX=0.0
      SYY=0.0
      SXXY=0.0
      SXXX=0.0
      SXYY=0.0
      SYYY=0.0
      SXXYY=0.0
```

```
      SXXXY=0.0
      SXYYY=0.0
      SXXXX=0.0
      SYYYY=0.0
      DO 20 I=1,4
      DO 10 J=1,4
      X2=X(J)*X(J)
      Y2=Y(I)*Y(I)
      X3=X(J)**3
      Y3=Y(I)**3
      SX=SX+X(J)
      SY=SY+Y(I)
      SXY=SXY+X(J)*Y(I)
      SXX=SXX+X2
      SYY=SYY+Y2
      SXXY=SXXY+X2*Y(I)
      SXXX=SXXX+X3
      SXYY=SXYY+X(J)*Y2
      SYYY=SYYY+Y3
      SXXYY=SXXYY+X2*Y2
      SXXXY=SXXXY+X3 * Y(I)
      SXYYY=SXYYY+X(J)*Y3
      SXXXX = SXXXX + X(J)**4
      SYYYY = SYYYY + Y(I)**4
   10 CONTINUE
   20 CONTINUE
      A(1,2)=SX
      A(1,3)=SY
      A(1,4)=SXY
      A(1,5)=SXX
      A(1,6)=SYY
      A(2,1)=A(1,2)
      A(2,2)=A(1,5)
      A(2,3)=A(1,4)
      A(2,4)=SXXY
      A(2,5)=SXXX
      A(2,6)=SXYY
      A(3,1)=A(1,3)
      A(3,2)=A(2,3)
      A(3,3)=A(1,6)
      A(3,4)=A(2,6)
      A(3,5)=A(2,4)
      A(3,6)=SYYY
      A(4,1)=A(1,4)
      A(4,2)=A(2,4)
      A(4,3)=A(3,4)
      A(4,4)=SXXYY
      A(4,5)=SXXXY
      A(4,6)=SXYYY
      A(5,1)=A(1,5)
      A(5,2)=A(2,5)
      A(5,3)=A(3,5)
      A(5,4)=A(4,5)
      A(5,5)=SXXXX
      A(5,6)=A(4,4)
      A(6,1)=A(1,6)
      A(6,2)=A(2,6)
      A(6,3)=A(3,6)
      A(6,4)=A(4,6)
      A(6,5)=A(5,6)
```

```
      A(6,6)=SYYYY
C
C FORM RIGHT HAND SIDE
C
      SF=0.0
      SFX=0.0
      SFY=0.0
      SFXY=0.0
      SFXX=0.0
      SFYY=0.0
C
C J=ROW NUM.  K=COL NUM.
C
      DO 30 I=1,16
      J=INT((I-1)/4.)+1
      K=I-(4*J)+4
      SF=SF+D(I)
      SFX=SFX+D(I)*X(J)
      SFY=SFY+D(I)*Y(K)
      SFXY=SFXY+D(I)*X(J)*Y(K)
      SFXX=SFXX+D(I)*X(J)*X(J)
      SFYY=SFYY+D(I)*Y(K)*Y(K)
   30 CONTINUE
      B(1)=SF
      B(2)=SFX
      B(3)=SFY
      B(4)=SFXY
      B(5)=SFXX
      B(6)=SFYY
      RETURN
      END
C
C
      SUBROUTINE GJSOLV(A,B,N)
      DIMENSION A(N,N), B(N)
C
C J=PIVOT ROW=PIVOT COLUMN; I=COLUMN NUMBER; K=NON-PIVOT ROW NUMBER
C
      DO 40 J=1,N
C
C SET PIVOT ELEMENT EQUAL TO 1.0
C
      DIV=A(J,J)
      DO 10 I=1,N
      A(J,I)=A(J,I)/DIV
   10 CONTINUE
      B(J)=B(J)/DIV
C
C SET COLUMN ELEMENTS OTHER THEN PIVOT ELEMENT EQUAL TO 0.0
C
      DO 30 K=1,N
      IF(K.EQ.J) GO TO 30
      DIV=A(K,J)
      DO 20 I=1,N
      A(K,I)=A(K,I)-DIV*A(J,I)
   20 CONTINUE
      B(K)=B(K)-DIV*B(J)
   30 CONTINUE
   40 CONTINUE
      RETURN
```

```
      END
C
C
C REVIEW AND/OR ALTER PARAMETERS
C
      SUBROUTINE REVIEW
      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
      COMMON/AE/IP,IFRCT,XDAMP,AO,FRCT
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/AI/IBKWTR,IBKWPT,XBW,YBW
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      DIMENSION IBKWPT(5),XBW(5,10),YBW(5,10)
C
      WRITE(6,10)T
   10 FORMAT(' THE WAVE CONDITIONS IN THE DEEP WATER REGION',
     * ' ARE AS FOLLOWS:'/ '      PERIOD= ',F10.4)
      CALL RCHECK(T)
      ADEG=ALPHA*180./3.14159265
      WRITE(6,20)ALPHA,ADEG
   20 FORMAT('      INCIDENT ANGLE = ',F10.4,' RAD. = ',F10.4,' DEG.')
      CALL RCHECK(ADEG)
      ALPHA=ADEG*3.14159265/180.
      WRITE(6,30)G
   30 FORMAT('      ACCELERATION DUE TO GRAVITY = ',F10.4)
      CALL RCHECK(G)
      WRITE(6,40)AO
   40 FORMAT('      WAVE AMPLITUDE = ',F10.4)
      CALL RCHECK(AO)
      WRITE(6,41)TIDE
   41 FORMAT('      TIDE LEVEL = ',F10.4)
      CALL RCHECK(TIDE)
      WRITE(6,50)XO
   50 FORMAT('      REFERENCE POINT FOR REFERENCE LINE:'/
     * '          X-COORDINATE = ',F15.4)
      CALL RCHECK(XO)
      WRITE(6,60)YO
   60 FORMAT('          Y-COORDINATE = ',F15.4)
      CALL RCHECK(YO)
      WRITE(6,111)IOPTCO
  111 FORMAT('          OPTION OF COORDINATES = ',I5)
      CALL ICHECK(IOPTCO)
      WRITE(6,112)IOPTBU
  112 FORMAT('          OPTION OF UPWAVE-SIDE BOUNDARY CONDITION = ',I5)
      CALL ICHECK(IOPTBL)
      WRITE(6,113)IOPTBD
  113 FORMAT('          OPTION OF DOWNWAVE-SIDE BOUNDARY CONDITION = ',I5)
      CALL ICHECK(IOPTBR)
      MX1=MX-1
      NY2=NY-2
      WRITE(6,120)MX1
  120 FORMAT(///' DESCRIPTION OF NEAR FIELD :'/
     * '        LAY-OUT OF GRID MESH:'/
     * '          NUMBER OF NODES IN X-DIRECTION MX-1 = ',I5)
      CALL ICHECK(MX1)
      MX=MX1+1
      WRITE(6,130)NY2
  130 FORMAT('          NUMBER OF NODES IN Y-DIRECTION NY-2 = ',I5)
```

```
      CALL ICHECK(NY2)
      NY=NY2+2
      WRITE(6,140)S1
  140 FORMAT('    THE ESTIMATED SLOPE AT X(1) (BASELINE) = ',F10.5)
      CALL RCHECK(S1)
      WRITE(6,150)S2
  150 FORMAT('        THE ESTIMATED SLOPE AT X(MX-1) = ',F10.5)
      WRITE(6,160)DC
  160 FORMAT('        DEPTH AT CONSTANT REGION = ',F10.5)
      CALL RCHECK(DC)
      WRITE(6,161)DBASE
  161 FORMAT('        DEPTH AT BASELINE = ',F10.5)
      CALL RCHECK(DBASE)
      WRITE(6,250)NN
  250 FORMAT(///'  OTHER COMPUTATIONAL PARAMETERS :'/
     *' NUMBER OF POINTS ON REFERENCE LINE TO LANDWARD (NN) = ',I5)
      CALL ICHECK(NN)
      WRITE(6,260)N
  260 FORMAT('        NUMBER OF POINTS TO SEAWARD (N) = ',I5)
      CALL ICHECK(N)
      WRITE(6,270)M
  270 FORMAT('        NUMBER OF MARCHING STEPS (M) = ',I5)
      CALL ICHECK(M)
      WRITE(6,275)NTRUC
  275 FORMAT('        NUMBER OF NODES TO BE USED IN CALC.(NTRUC) = ',I5)
      CALL ICHECK(NTRUC)
      WRITE(6,280)DSIG
  280 FORMAT(' STEP SIZE ALONG MARCHING DIR. (DELTA SIGMA) = ',F15.4)
      CALL RCHECK(DSIG)
      WRITE(6,290)DRHO
  290 FORMAT(' STEP SIZE ALONG TRANSVERSIAL DIR.(DELTA RHO) = ',F15.4)
      CALL RCHECK(DRHO)
      WRITE(6,310)IFRCT
  310 FORMAT('        FRICTION CONSIDERATION (IFRCT) = ',I5/
     * '        IFRCT = 1 MEANS CONSIDER FRICTION'/
     * '        IFRCT = 0 MEANS NEGLECT BOTTOM FRICTION')
      CALL ICHECK(IFRCT)
      IF(IFRCT.EQ.1) GO TO 320
      XDAMP=0.
      FRCT=0.
      GO TO 350
  320 WRITE(6,330)XDAMP
  330 FORMAT('        X-LOCATION AT WHICH TO START FRICTION ',
     * 'CONSIDERATION = ',F15.4)
      CALL RCHECK(XDAMP)
      WRITE(6,340)FRCT
  340 FORMAT('        FRICTION FACTOR = ',F10.6)
      CALL RCHECK(FRCT)
  350 WRITE(6,430)IP
  430 FORMAT('        SCAN EVERY IP STEPS; IP = ',I5)
      CALL ICHECK(IP)
      WRITE(6,440)IDEPM
  440 FORMAT('        PRINT MODE - BACKGROUND DEPTH (IDEPM) = ',I5/
     * '        IDEPM = 1 MEANS OUTPUT BACKGROUND DEPTHS'/
     * '        IDEPM = 0 MEANS DO NOT OUTPUT DEPTHS.')
      CALL ICHECK(IDEPM)
      WRITE(6,450)IPLINE
  450 FORMAT('        PRINT MODE - REFERENCE LINE (IPLINE) = ',I5/
     * '        IPLINE = 1 MEANS OUTPUT REFERENCE LINE'/
     * '        IPLINE = 0 MEANS DO NOT OUTPUT ORIGINAL LINE')
```

```
      CALL ICHECK(IPLINE)
      WRITE(6,35)IBREAK
   35 FORMAT(' ENTER IBREAK: =0 FOR NO WAVE BREAKING,'/
     * '    =1 FOR BREAKING BUT DO NOT OUTPUT BREAKING DATA'/
     * '    =2 FOR BREAKING AND DATA FILE OF BREAK LOCS+AMPS.'/
     * ' PRESENT IBREAK = ',I5)
      CALL ICHECK(IBREAK)
      WRITE(6,8)ICURRN
    8 FORMAT(' ICURRN = 1 : PRESENCE OF CURRENT FIELD,'/
     * '    = 0 : NO CURRENT FIELD.',I5)
      CALL ICHECK(ICURRN)
      WRITE(6,5)IBACKD
    5 FORMAT(' ENTER CHOICE FOR DEPTH INTERPOLATION SCHEMES:'/
     * '  BACKGROUND DEPTH; IBACKD = 0 IS FOR PLANE BEACH WITH'/
     * '        SLOPE = 0.01  (USED FOR DEBUGGING).'/
     * '        IBACKD=1 IS FOR CUBIC SPLINE OVER AVG. DEPTH AT EACH ROW'
     * /'        IBACKD=2 IS LEAST SQUARE CUBIC EQN. IN X-DIRECTION.'/
     * '  PRESENT IBACKD = ',I5)
      CALL ICHECK(IBACKD)
      WRITE(6,7)IREALD
    7 FORMAT(//'  ACTUAL DEPTH;  IREALD=0 IS PLANE BEACH WITH SLOPE'/
     * '       EQUAL 0.01  (USED FOR DEBUGGING).'/
     * '       IREALD=1 IS LINEAR AVG. OF 4 SURROUNDING GRID POINTS.'/
     * '       IREALD=2 USES A 16 POINT GRID FOR A CUBIC SPLINE ACROSS'/
     * '        EACH OF 4 ROWS AND THEN ONCE DOWN THE INTERPOLATED '/
     * '        DEPTHS ALONG THE DESIRED Y-VALUE.'/
     * '       IREALD=3 IS LIKE IREALD=2 EXCEPT THE SPLINE IS DONE ON '/
     * '        THE COLUMNS AND THEN THE ROW OF THE DESIRED X-VALUE.'/
     * '       IREALD=4 IS A LEAST SQUARE FIT OF THE 16 POINT GRID TO'/
     * '        A 6 COEFFICIENT DEPTH EXPRESSION.'/
     * '       PRESENT IREALD = ',I5)
      CALL ICHECK(IREALD)
      RETURN
      END
C
C
      SUBROUTINE RCHECK(X)
      WRITE(6,10)
   10 FORMAT('  DO YOU WISH TO CHANGE THIS VALUE ?'/
     * '       ENTER 1 FOR YES, 0 FOR NO')
      READ(5,*)I
      IF(I.NE.1) GO TO 99
      WRITE(6,20)X
   20 FORMAT('  OLD VALUE = ',F20.6,'   ENTER NEW VALUE :')
      READ(5,*)X
   99 RETURN
      END
C
C
      SUBROUTINE ICHECK(J)
      WRITE(6,10)
   10 FORMAT('  DO YOU WISH TO CHANGE THIS VALUE ?'/
     * '       ENTER 1 FOR YES, 0 FOR NO')
      READ(5,*)I
      IF(I.NE.1) GO TO 99
      WRITE(6,20)J
   20 FORMAT('  OLD VALUE = ',I5,'   ENTER NEW VALUE :')
      READ(5,*)J
   99 RETURN
      END
```

```
C
C
      SUBROUTINE MAKEC(C)
      COMMON/AC/NN,M,XO,YO,T,XUB,XLB,YLB,YRB,ALPHA,IOPTCO
      COMMON/AD/S1,S2,IOPTBU,IOPTBD,IBATCH
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      COMMON/DI/IBACKD,IREALD,IBREAK,ICURRN
      DIMENSION XI(134),YI(133),DEP(134,133),C(4,134),TEMP(134)
      DIMENSION U(134,133),V(134,133),TEMP1(134),TEMP2(134)
      MX1=MX-1
      MX2=MX-2
      NY1=NY-1
      NY2=NY-2
      DO 2 I=1,134
      TEMP1(I)=0.
    2 TEMP2(I)=0.
      READ(9,*) IFLIP
      IF(IFLIP .EQ. 2) GO TO 81
      DO 10 I=1,MX1
      READ(9,*) (TEMP(L),L=2,NY1)
      IF(ICURRN .EQ. 0) GO TO 61
      READ(11,*)(TEMP1(L),L=2,NY1)
      READ(12,*)(TEMP2(L),L=2,NY1)
   61 IF(IFLIP .EQ. 1) GO TO 7
      DO 5 L=2,NY1
      U(I,L)=TEMP1(L)
      V(I,L)=TEMP2(L)
    5 DEP(I,L)=TEMP(L)+TIDE
      GO TO 10
    7 DO 8 L=2,NY1
      J=NY-L+1
      U(I,L)=TEMP1(J)
      V(I,L)=TEMP2(J)
    8 DEP(I,L)=TEMP(J)+TIDE
   10 CONTINUE
      GO TO 82
   81 DO 83 I=2,NY1
      READ(9,*) (TEMP(L),L=1,MX1)
      IF(ICURRN .EQ. 0) GO TO 85
      READ(11,*)(TEMP1(L),L=1,MX1)
      READ(12,*)(TEMP2(L),L=1,MX1)
   85 DO 84 L=1,MX1
      DEP(L,I)=TEMP(L)+TIDE
      U(L,I)=TEMP1(L)
      V(L,I)=TEMP2(L)
   84 CONTINUE
   83 CONTINUE
   82 READ(10,*) IFORMX
      IF(IFORMX.NE.1) GO TO 30
      READ(10,*) XI(1),XI(MX1),XDEL
      DO 20 I=2,MX2
      XI(I)=XI(I-1)+XDEL
   20 CONTINUE
      GO TO 35
   30 READ(10,*)(XI(LL),LL=1,MX1)
   35 READ(10,*) IFORMY
      IF(IFORMY.NE.1) GO TO 50
      READ(10,*) YI(2),YI(NY1),YDEL
      DO 40 I=3,NY2
```

```
      YI(I)=YI(I-1)+YDEL
   40 CONTINUE
      GO TO 55
   50 READ(10,*) (YI(L),L=2,NY1)
C
C CREATE ARTIFICIAL FAR FIELD AT AN ARBITRARY DISTANCE
C
   55 XI(MX)=50.*(XI(MX1)-XI(1))
      FAR=50.*(YI(NY1)-YI(2))
      YI(1)=YI(2)-FAR
      YI(NY)=YI(NY1)+FAR
      XUB=XI(1)
      XLB=XI(MX1)
      YRB=YI(NY1)
      YLB=YI(2)
      IF(IBATCH .EQ. 2) GO TO 45
      WRITE(6,21)
   21 FORMAT(' DO YOU WANT TO REVIEW THE DEPTH AND CURRENT DATA?'//
     * '        ENTER 1 FOR YES, 0 FOR NO')
      READ(5,*)I
      IF(I .NE. 1) GO TO 45
      WRITE(6,17)(YI(L),L=2,NY1)
   17 FORMAT(' CROSS-SETIONS OF DEPTH AT YI= '//,5F16.4)
      WRITE(6,18)
   18 FORMAT(' IF DATA ARE GOOD, INPUT (1-9) TO CONTINUE,'/
     * 'OTHERWISE INPUT 0 TO STOP')
      READ(5,*) IGOING
      IF(IGOING .EQ. 0) STOP
      WRITE(6,11)
   11 FORMAT(//' THE INPUT DEPTH DATA WILL BE PRINTED AT EACH SECTION
     *  ALONG Y=YI BY FREE FORMAT,'/' THEN X-COMPONENT OF CURRENT AND
     *  Y-COMPONENT OF CURRENT IF CURRENT PRESENTS')
      DO 13 I=1,MX1
      WRITE(6,16)I,XI(I)
      WRITE(6,*)(DEP(I,L),L=2,NY1)
      IF(ICURRN .EQ. 0) GO TO 13
      WRITE(6,*)(U(I,L),L=2,NY1)
      WRITE(6,*)(V(I,L),L=2,NY1)
   13 CONTINUE
   16 FORMAT('  XI AT ROW =  ',I5,'  IS  ',F16.4//' DEPTH AND CURRENT
     & ALONG X = XI ARE :'/ )
      WRITE(6,12)
   12 FORMAT(' IF DEPTH AND/OR CURRENTDATA ARE GOOD, INPUT (1-9) TO
     * CONTINUE,'/' OTHERWISE INPUT 0 TO STOP')
      READ(5,*) IGOING
      IF(IGOING .EQ. 0) STOP
   45 IF(IBACKD.LE.0) GO TO 71
      IF(IBACKD.EQ.1) GO TO 57
C
C ALTERNATE BACKGROUND - LEAST SQUARE FIT FOR ONE CUBIC EQN.
C FOR WHOLE BACKGROUND, NOT SEPARATE EQNS. FOR EACH SEGMENT.
C
      CALL LSBFIT(MX,NY,XI,DEP,C)
      GO TO 58
C
C CALL CUSPIP TO RETURN THE ARRAY C FOR A CUBIC
C SPLINE ALONG THE AVERAGE DEPTH AT EACH ROW.
C
   57 CALL CUSPIP(MX,NY,XI,YI,DEP,C,S1,S2,DBASE,DC,TIDE)
C
```

```
C CALL PCUBIC ONCE FOR EACH ROW OF DEPTH DATA
C
   58 DO 60 I=1,MX1
      DEP(I,1)=PCUBIC(XI(I))
C
C SET DEPTH ALONG Y=YRB EQUAL TO THAT CALCULATED AT Y=YLB
C
      DEP(I,NY)=DEP(I,1)
   60 CONTINUE
C
C SET DEPTH ALONG FAR FIELD AS SPECIFIED BY USER
C
      DO 70 J=1,NY
      DEP(MX,J)=DC+TIDE
   70 CONTINUE
      RETURN
   71 XUB=0.0
      XLB=1.E9
      YRB=1.E9
      YLB=-1.E9
      RETURN
      END
C
C
C LEAST SQUARES FIT OF CUBIC FUNCTION TO BACKGROUND DEPTH
C (INVARIANT IN Y-DIRECTION)
C
      SUBROUTINE LSBFIT(MX,NY,XI,DEP,C)
      DIMENSION A(4,4),B(4),XI(134),DEP(134,133),C(4,134)
      CALL MAKEQ2(A,B,XI,MX,NY,DEP)
      A(1,1)= 1.0*(MX-1) *(NY-2)
      N=4
      CALL GJSOLV(A,B,N)
      C(1,4)=B(1)
      C(2,4)=B(2)
      C(3,4)=B(3)
      C(4,4)=B(4)
      RETURN
      END
C
C
      SUBROUTINE MAKEQ2(A,B,XGRID,MX,NY,DEP)
      DIMENSION A(4,4),B(4),XGRID(134),DEP(134,133)
      IX=MX-1
      IY=NY-2
      IY1=NY-1
      SX=0.0
      S2X=0.0
      S3X=0.0
      S4X=0.0
      S5X=0.0
      S6X=0.0
      DO 10 I=1,IX
      SX=SX+XGRID(I)
      S2X=S2X+XGRID(I)*XGRID(I)
      S3X=S3X+XGRID(I)**3
      S4X=S4X+XGRID(I)**4
      S5X=S5X+XGRID(I)**5
      S6X=S6X+XGRID(I)**6
   10 CONTINUE
```

```
      SX=SX*IY
      S2X=S2X*IY
      S3X=S3X*IY
      S4X=S4X*IY
      S5X=S5X*IY
      S6X=S6X*IY
      A(1,2)=SX
      A(1,3)=S2X
      A(1,4)=S3X
      A(2,1)=A(1,2)
      A(2,2)=A(1,3)
      A(2,3)=A(1,4)
      A(2,4)=S4X
      A(3,1)=A(1,3)
      A(3,2)=A(2,3)
      A(3,3)=A(2,4)
      A(3,4)=S5X
      A(4,1)=A(1,4)
      A(4,2)=A(2,4)
      A(4,3)=A(3,4)
      A(4,4)=S6X
      SF=0.0
      SFX=0.0
      SF2X=0.0
      SF3X=0.0
      DO 30 I=1,IX
      DO 20 J=2,IY1
      SF=SF+DEP(I,J)
      SFX=SFX+DEP(I,J)*XGRID(I)
      SF2X=SF2X+DEP(I,J)*XGRID(I)*XGRID(I)
      SF3X=SF3X+DEP(I,J)*XGRID(I)**3
   20 CONTINUE
   30 CONTINUE
      B(1)=SF
      B(2)=SFX
      B(3)=SF2X
      B(4)=SF3X
      RETURN
      END
C
C
C SKETCH THE BOTTOM TOPOGRAPHY BENEATH SOME PROFILE OF INTEREST
C
      SUBROUTINE SIDEVW(NUM,X1,Y1,X2,Y2)
      COMMON/AF/NTRUC,IDEPM,IPLINE,DC,DBASE,MX,NY,TIDE
      COMMON/AG/XI,YI,DEP,U,V
      DIMENSION X1(10),Y1(10),X2(10),Y2(10)
      DIMENSION XI(134),YI(133),DEP(134,133),U(134,133),V(134,133)
      IX=1
      IX1=2
      IY=1
      IY1=2
   15 WRITE(6,20)
   20 FORMAT(' ENTER 1-9 TO VIEW A PROFILE ALREADY SPECIFIED,'/
     *  '    ENTER 0 TO DEFINE AN ALTERNATE PROFILE:')
      READ(5,*) IDUM
      IF(IDUM.EQ.0) GO TO 60
   25 WRITE(6,30)
   30 FORMAT(' ENTER THE NUMBER OF THE PROFILE YOU WISH TO VIEW:')
      READ(5,*) IPROF
```

```
      IF(IPROF.GT.NUM) GO TO 40
      IF(IPROF.LT.1) GO TO 40
      XA=X1(IPROF)
      XB=X2(IPROF)
      YA=Y1(IPROF)
      YB=Y2(IPROF)
      GO TO 80
   40 WRITE(6,50) NUM
   50 FORMAT(' PROFILE NO. MUST BE BETWEEN 1 AND  ',I5,'  INCLUSIVE.')
      GO TO 25
   60 WRITE(6,70)
   70 FORMAT(' ENTER THE ENDPOINTS OF THE DESIRED SECTION,'/
     * 8X,' (XA,YA) AND (XB,YB):')
      READ(5,*) XA,YA,XB,YB
      IF(XA.NE.XB) GO TO 80
      IF(YA.NE.YB) GO TO 80
      GO TO 60
C
C SET PARAMETERS TO SKETCH PROFILE BETWEEN (XA,YA) AND (XB,YB)
C
   80 IF(XA.NE.XB) GO TO 90
      IAXIS=2
      GO TO 140
   90 IF(YA.NE.YB) GO TO 100
      IAXIS=1
      GO TO 120
  100 WRITE(6,110)
  110 FORMAT(' ENTER 1 TO PLOT BY X VALUES, ENTER 2 FOR Y VALUES:')
      READ(5,*) IAXIS
C
C SECTION TO PLOT BY X VALUES (IAXIS=1)
C
      IF(IAXIS .EQ. 2) GO TO 140
  120 IF(XA.LE.XB) GO TO 130
      XHOLD=XA
      YHOLD=YA
      XA=XB
      YA=YB
      XB=XHOLD
      YB=YHOLD
  130 ABASE=XA-0.1*(XB-XA)
      BBASE=XB+0.1*(XB-XA)
      A=XA
      B=XB
      GO TO 160
  140 IF(YA.LE.YB) GO TO 150
      XHOLD=XA
      YHOLD=YA
      XA=XB
      YA=YB
      XB=XHOLD
      YB=YHOLD
  150 ABASE=YA-0.1*(YB-YA)
      BBASE=YB+0.1*(YB-YA)
      A=YA
      B=YB
  160 AMAX=DEP(1,1)
      AMIN=DEP(1,1)
      DO 161 I=1,MX
      DO 161 J=1,NY
```

```
      IF(DEP(I,J) .GT. AMAX) AMAX=DEP(I,J)
      IF(DEP(I,J) .LT. AMIN) AMIN=DEP(I,J)
  161 CONTINUE
      C=-AMAX
      D=-AMIX
      WRITE(6,170) C,D
  170 FORMAT(' DEPTH VARIES FROM   ',F15.3,'  TO  ',F15.3/
     *  10X,'ENTER 0 IF OK, 1 TO CHANGE:')
      READ(5,*) IDUM
      IF(IDUM.NE.1) GO TO 190
      WRITE(6,180)
  180 FORMAT(' ENTER NEW MINIMUM AND MAXIMUM DEPTHS:')
      READ(5,*) D,C
      IF(C.LT.D) GO TO 190
      HOLD=C
      C=D
      D=HOLD
  190 CBASE=C-0.1*(D-C)
      DBASE=D+0.1*(D-C)
      HORINC=(XB-XA)/10.
      IF(IAXIS .EQ. 2)HORINC=(YB-YA)/10.
      VERINC=(D-C)/10.
      WRITE(6,200) HORINC
  200 FORMAT('  INCREMENTS IN HORIZONTAL DIRECTION= ',F12.3/
     * '  ENTER 0 IF OK, 1 TO CHANGE')
      READ(5,*) IDUM
      IF(IDUM.NE.1) GO TO 220
      WRITE(6,210)
  210 FORMAT('  ENTER NEW VALUE:')
      READ(5,*) HORINC
  220 WRITE(6,230) VERINC
  230 FORMAT(' GRID INCREMENT IN VERTICAL DIRECTION= ',F12.3/
     * '  ENTER 0 IF OK, 1 TO CHANGE')
      READ(5,*) IDUM
      IF(IDUM.NE.1) GO TO 240
      WRITE(6,210)
      READ(5,*) VERINC
  240 H=0.0
      VE=0.0
  250 IF(H.LE.A) GO TO 260
      H=H-HORINC
      GO TO 250
  260 IF(VE.LE.D) GO TO 270
      VE=VE-VERINC
      GO TO 260
  270 CALL INITT(120)
      CALL BINITT
      CALL DWINDO(ABASE,BBASE,CBASE,DBASE)
      CALL MOVEA(A,C)
      CALL DRAWA(A,D)
      CALL DRAWA(B,D)
      CALL DRAWA(B,C)
      CALL DRAWA(A,C)
C
C DRAW GRID
C
  280 CALL ANMODE
      VE=VE-VERINC
      IF(VE.GE.D) GO TO 280
      IF(VE.LE.(C+VERINC)) GO TO 290
```

```
      CALL MOVEA(A,VE)
      CALL DASHA(B,VE,1)
      GO TO 280
  290 CALL ANMODE
      H=H+HORINC
      IF(H.LE.A) GO TO 290
      IF(H.GT.(B-HORINC)) GO TO 300
      CALL MOVEA(H,C)
      CALL DASHA(H,D,1)
      GO TO 290
  300 CALL ANMODE
      XINC=(XB-XA)/50.
      YINC=(YB-YA)/50.
      X=XA
      Y=YA
C
C DRAW REAL DEPTH PROFILE
C
  310 CALL ANMODE
      CALL DEPINP(IX,IX1,IY,IY1,X,Y,DR,UX,VY,DIVU)
      DR=-DR
      Q=X
      IF(IAXIS.EQ.1) GO TO 320
      Q=Y
  320 CALL MOVEA(Q,DR)
  330 CALL ANMODE
      X=X+XINC
      Y=Y+YINC
      IF(X.GE.(XB) .AND. IAXIS .EQ. 1) GO TO 400
      IF(Y.GE.(YB+YINC) .AND. IAXIS .EQ. 2) GO TO 400
      CALL DEPINP(IX,IX1,IY,IY1,X,Y,DR,UX,VY,DIVU)
      DR=-DR
      Q=X
      IF(IAXIS.EQ.1) GO TO 340
      Q=Y
  340 CALL DRAWA(Q,DR)
      GO TO 330
C
C DRAW BACKGROUND PROFILE
C
  400 X=XA
      Y=YA
  410 CALL ANMODE
      DB=-PCUBIC(X)
      Q=X
      IF(IAXIS.EQ.1) GO TO 420
      Q=Y
  420 CALL MOVEA(Q,DB)
  430 CALL ANMODE
      X=X+XINC
      Y=Y+YINC
      IF(X.GE.(XB) .AND. IAXIS .EQ. 1) GO TO 500
      IF(Y.GE.(YB+YINC) .AND. IAXIS .EQ. 2) GO TO 500
      DB=-PCUBIC(X)
      Q=X
      IF(IAXIS.EQ.1) GO TO 440
      Q=Y
  440 CALL DRAWA(Q,DB)
      GO TO 430
  500 WRITE(6,510)
```

```
  510 FORMAT(' ENTER 1-9 TO VIEW ANOTHER PROFILE, ENTER 0',
     *  ' TO PROCEED.')
      READ(5,*) IDUM
      IF(IDUM.NE.0) GO TO 15
      CALL FINITT(0,700)
      RETURN
      END
C
C
C SUBROUTINE BounDarY GRid
C   TO FIND THE BOUNDARY OF THE COMPUTATIONAL REGION
C INPUT: XTIP, YTIP, XG, YG, THETA, MX, XI, C, XLB
C RETURNED: XG(1),YG(1)
C
      SUBROUTINE BDYGRD(XG,YG,THETA,MX,XI,C,XLB,IOPTCO,COSINE,SINE)
      COMMON/AB/N,MM,BETA,OMEGA,G,DSIG,DRHO,WKO
      DIMENSION XG(N),YG(N),XI(MX),C(4,134)
      PAI=3.14159265
      MX1=MX-1
      DINTC1=0.
      IDIRC=1
      IF(BETA .LT. 0.) IDIRC=-1
C
C RECALL: XG(N) AND YG(N) STORED THE COORDINATES OF THE
C REFERENCE POINT ON THE PHASE LINE AS IT MOVES TOWARD
C SHORE. THEREFORE XG(1)=XO AND YG(1)=YO.
C
      GDNE1=-DSIG
      IF(IOPTCO .EQ. 1) GO TO 11
      IF(IOPTCO .EQ. 2) GO TO 12
      XX1=XG(1)
      YY1=YG(1)
      DGDNE1=GDNE1/MM
      DO 100 KK=1,MM
      IF(XX1 .LE. XLB) GO TO 50
      WK1=WKO
      GO TO 60
   50 D1=PCUBIC(XX1)
      CALL WAVENO(D1,WK1,GC1,PGC1,IDEPTH)
   60 CALL CURVIL(BETA,WK1,THE1,DGDNE1,DX1,DY1,IOPTCO)
C
C INCREMENT THE LOCATION OF THE REFERENCE POINT
C
      XX1=XX1+IDIRC*DX1
      DINTC1=DINTC1+DY1
C
  100 CONTINUE
      YY1=YY1+IDIRC*(DSIG+DINTC1)
      XG(1)=XX1
      YG(1)=YY1
      RETURN
   11 DX=DSIG*COSINE
      DY=DSIG*SINE
      XG(1)=XG(1)-DX
      YG(1)=YG(1)+DY
      RETURN
   12 XG(1)=XG(1)-DSIG
      YG(1)=YG(1)
      RETURN
      END
```

4.4 EXAMPLES OF PROGRAM RUNNING SESSIONS

THE PROGRAM FACILITATES THREE OPTIONS OF RUNNING SESSIONS. THEY ARE (i) INTERACTIVE, (ii) SEMI-INTERACTIVE AND (iii) BATCH MODES. IN THIS SECTION WE USE THE CASE OF WAVES AROUND A PERPENDICULAR BREAKWATER TO ILLUSTRATE WHAT A USER CAN OBSERVE ON THE SCREEN OF A TERMINAL.

(i) INTERACTIVE MODE

THIS MODE REQUIRES A USER TO INPUT DATA FROM THE KEYBOARD EXCEPT THE FILES OF DEPTH.DAT, LOC.DAT AND/OR CURRNX.DAT AND CURRNY.DAT. WHEN THIS MODE IS CHOSEN, THE PARAMETERS INPUT FROM THE KEYBOARD WILL BE SAVED IN THE FILE OF IN.DAT AUTOMATICALLY FOR LATER USE. THIS WILL ELLIMINATE THE EFFORTS TO KEY IN ALL PARAMETERS FROM TIME TO TIME. A USER CAN EITHER CHOOSE THE SEMI-INTERACTIVE MODE TO CHANGE PARAMETERS WHILE RUNNING THE JOB OR EDIT THE FILE OF IN.DAT BEFORE RUNNING THE JOB. THE FOLLOWINGS WILL APPEAR ON THE SCREEN INCLUDING USER'S RESPONSES TO THE QUESTIONS.

```
$RUN PARAWAVE



THIS IS A REMINDER!!!

HAVE YOU PREPARED FILES OF DEPTH.DAT AND LOC.DAT??

HAVE YOU PREPARED FILES OF CURRNX.DAT AND CURRNY.DAT
IF CURRENT FIELD IS  TO BE CONSIDERED??

INPUT (1-9) TO CONTINUE; 0 TO STOP

          1
WHICH MODE DO YOU WANT??

2=BATCH; FROM THIS POINT ON YOU CAN NOT ALTER ANY PARAMETERS
1=SEMI-INTERACTIVE; NO DATA INPUT FROM KEYBOARD, BUT AT
  SEVERAL BREAKPOINTS PROGRAM ALLOWS YOU TO ADJUST PARAMETERS
0=INTERACTIVE; ALL DATA INPUT FROM KEYBOARD EXCEPT DEPTH.DAT,
  LOC.DAT, AND/OR CURRNX.DAT AND CURRNY.DAT. YOU CAN ALSO
  ADJUST PARAMETERS

          0
CHOOSE OPTION FOR COORDINATES (IOPTCO)
0:CURVILINEAR;
1:CARTESIAN (PROPAGATION DIRECTION);
2:FIXED CARTESIAN

          0
CHOOSE OPTION FOR B.C.
(IOPTBU:UPWAVE-SIDE BOUNDARY, IOPTBD:DOWNWAVE-SIDE BOUNDARY);
0:OPEN; 1:SOLID

          0          0
INPUT:AO,T,ALPHAD,G,TIDE, FREE FORMAT

  1.000000     1.000000     20.00000     32.20000     0.0000000E+00
```

```
INPUT:MXGRID,NYGRID;FREE FORMAT

          7           2
INPUT:XO,YO,DSIG,DRHO,N,M,S1,S2,DC,DBASE;FREE FORMAT

   15.00000      -25.00000      0.2500000      0.2500000              250
          260  5.0000001E-02  0.0000000E+00   1.000000       0.0000000E+00
INPUT:IP; FREE FORMAT

          1
ENTER CHOICE FOR BACKGROUND DEPTH INTERPOLATION :
IBACKD = 0 :PLANE BEACH WITH SLOPE = 0.01 (DEBUGGING)
       = 1 :CUBIC SPLINE OVER AVG. DEPTH AT EACH ROW
       = 2 :LEAST SQUARE CUBIC EQN. IN X-DIRECTION.

ENTER IBACKD:

          2


ENTER CHOICE FOR ACTUAL DEPTH INTERPOLATION :
IREALD = 0 :PLANE BEACH WITH SLOPE = 0.01 (DEBUGGING)
       = 1 :LINEAR AVG. OF 4 SURROUNDING GRID POINTS.
       = 2 :USES A 16-POINT GRID FOR A CUBIC SPLINE ACROSS
       EACH OF 4 ROWS AND THEN THE COLUMNS OF THE DESIRED Y
       = 3 :LIKE IREALD=2 EXCEPT THE SPLINE IS DONE ON
       THE COLUMNS FIRST AND THEN THE ROW OF THE DESIRED X
       = 4 :A LEAST SQUARE FIT OF THE 16-POINT GRID TO
      A 6-COEFFICIENT DEPTH EXPRESSION

ENTER IREALD:

          2
INPUT:IDEPM,IPLINE; FREE FORMAT

          0           0
INPUT:IFRCT,XDAMP,FRCT

          0  0.0000000E+00  0.0000000E+00
ENTER IBREAK = 0 :NO WAVE BREAKING,
             = 1 :WAVE BREAKING IS CONSIDERED

          0
ENTER ICURRN = 1 :PRESENCE OF CURRENT FIELD
             = 0 :NO PRESENCE OF CURRENT FIELD.

          0
ENTER IBKWTR = 0 :NO PRESENCE OF BREAKWATER;
          = # :TOTAL NO. OF BREAKWATERS, MAX. NO. = 5

          1
ENTER TOTAL POINTS OF LINEAR SEGMENTS OF BREAKWATER NO. =      1
AND ITS COORDINATES, FIRST POINT STARTS FROM THE TIP OF THE BREAKWATER.
NO. OF POINTS CAN BE FROM 2  TO 10
INPUT IBKWPT(I),XBW(I,L),BYW(I,L),L=1,IBKWPT(I)

          2   15.00000      0.0000000E+00  0.0000000E+00  0.0000000E+00
ENTER TITLE, MAX. OF 80 CHARACTERS
```

```
CERC PERPENDICULAR BREAKWATER
INPUT THE NUMBER OF PROFILES TO BE INTERPOLATED,
 UP TO 10 PROFILES IS ALLOWED ON ONE RUN

          2
DO YOU WISH TO REVIEW THE DEFAULT PARAMETERS?
  ENTER 1 FOR YES, 0 FOR NO

          1
THE WAVE CONDITIONS IN THE DEEP WATER REGION ARE AS FOLLOWS:
    PERIOD=     1.0000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
    INCIDENT ANGLE =     0.3491 RAD. =     20.0000 DEG.
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
    ACCELERATION DUE TO GRAVITY =    32.2000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
    WAVE AMPLITUDE =     1.0000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
    TIDE LEVEL =     0.0000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
    REFERENCE POINT FOR REFERENCE LINE:
      X-COORDINATE =          15.0000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
      Y-COORDINATE =         -25.0000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
       OPTION OF COORDINATES =     0
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
       OPTION OF UPWAVE-SIDE BOUNDARY CONDITION =     0
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
       OPTION OF DOWNWAVE-SIDE BOUNDARY CONDITION =     0
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0


DESCRIPTION OF NEAR FIELD :
     LAY-OUT OF GRID MESH:
       NUMBER OF NODES IN X-DIRECTION MX-1 =     7
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
```

```
       NUMBER OF NODES IN Y-DIRECTION NY-2 =     2
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
   THE ESTIMATED SLOPE AT X(1) (BASELINE) =    0.05000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     THE ESTIMATED SLOPE AT X(MX-1) =    0.00000
     DEPTH AT CONSTANT REGION =    1.00000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     DEPTH AT BASELINE =    0.00000
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0



 OTHER COMPUTATIONAL PARAMETERS :
NUMBER OF POINTS ON REFERENCE LINE TO LANDWARD (NN) =   260
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     NUMBER OF POINTS TO SEAWARD (N) =   250
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     NUMBER OF MARCHING STEPS (M) =   260
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     NUMBER OF NODES TO BE USED IN CALC.(NTRUC) =   250
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
STEP SIZE ALONG MARCHING DIR. (DELTA SIGMA) =          0.2500
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
STEP SIZE ALONG TRANSVERSIAL DIR.(DELTA RHO) =          0.2500
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     FRICTION CONSIDERATION (IFRCT) =     0
       IFRCT = 1 MEANS CONSIDER FRICTION
       IFRCT = 0 MEANS NEGLECT BOTTOM FRICTION
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     SCAN EVERY IP STEPS; IP =     1
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
     PRINT MODE - BACKGROUND DEPTH (IDEPM) =     0
      IDEPM = 1 MEANS OUTPUT BACKGROUND DEPTHS
      IDEPM = 0 MEANS DO NOT OUTPUT DEPTHS.
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
```

```
          0
      PRINT MODE - REFERENCE LINE (IPLINE) =      0
       IPLINE = 1 MEANS OUTPUT REFERENCE LINE
       IPLINE = 0 MEANS DO NOT OUTPUT ORIGINAL LINE
  DO YOU WISH TO CHANGE THIS VALUE ?
      ENTER 1 FOR YES, 0 FOR NO
          0
 ENTER IBREAK: =0 FOR NO WAVE BREAKING,
   =1 FOR BREAKING BUT DO NOT OUTPUT BREAKING DATA
   =2 FOR BREAKING AND DATA FILE OF BREAK LOCS+AMPS.
 PRESENT IBREAK =      0
  DO YOU WISH TO CHANGE THIS VALUE ?
      ENTER 1 FOR YES, 0 FOR NO
          0
 ICURRN = 1 : PRESENCE OF CURRENT FIELD,
   = 0 : NO CURRENT FIELD.    0
  DO YOU WISH TO CHANGE THIS VALUE ?
      ENTER 1 FOR YES, 0 FOR NO
          0
 ENTER CHOICE FOR DEPTH INTERPOLATION SCHEMES:
  BACKGROUND DEPTH; IBACKD = 0 IS FOR PLANE BEACH WITH
       SLOPE = 0.01  (USED FOR DEBUGGING).
       IBACKD=1 IS FOR CUBIC SPLINE OVER AVG. DEPTH AT EACH ROW
       IBACKD=2 IS LEAST SQUARE CUBIC EQN. IN X-DIRECTION.
  PRESENT IBACKD =      2
  DO YOU WISH TO CHANGE THIS VALUE ?
      ENTER 1 FOR YES, 0 FOR NO
          0


  ACTUAL DEPTH;  IREALD=0 IS PLANE BEACH WITH SLOPE
      EQUAL 0.01  (USED FOR DEBUGGING).
      IREALD=1 IS LINEAR AVG. OF 4 SURROUNDING GRID POINTS.
      IREALD=2 USES A 16 POINT GRID FOR A CUBIC SPLINE ACROSS
       EACH OF 4 ROWS AND THEN ONCE DOWN THE INTERPOLATED
       DEPTHS ALONG THE DESIRED Y-VALUE.
      IREALD=3 IS LIKE IREALD=2 EXCEPT THE SPLINE IS DONE ON
       THE COLUMNS AND THEN THE ROW OF THE DESIRED X-VALUE.
      IREALD=4 IS A LEAST SQUARE FIT OF THE 16 POINT GRID TO
       A 6 COEFFICIENT DEPTH EXPRESSION.
      PRESENT IREALD =      2
  DO YOU WISH TO CHANGE THIS VALUE ?
      ENTER 1 FOR YES, 0 FOR NO
          0
 INPUT TWO END POINTS OF DESIRED PROFILE NO.=     1:
 X1,Y1 AND X2,Y2

   12.50000       -15.00000        12.50000        20.00000
 INPUT TWO END POINTS OF DESIRED PROFILE NO.=     2:
 X1,Y1 AND X2,Y2

   9.000000       -15.00000        9.000000        20.00000
 DO YOU WANT TO REVIEW THE DEPTH AND CURRENT DATA?

      ENTER 1 FOR YES, 0 FOR NO
          0
  (        34.777 ,        30.149 ) IS THE FARTHEST DISTANCE FROM SHORE
 WHERE CALCULATIONS CAN BE DONE FOR N=    250
 WARING: MAX. N IS 500
```

```
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0



CALCULATION HAS BEEN CONTINUING FOR M =    260  AND NEW N =    250


 (         1.447 ,       -21.708 ) IS THE CLOSEST DISTANCE FROM SHORE
WHERE CALCULATIONS CAN BE DONE FOR M=    260
WARING: MAX. M IS 1500


 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0



CALCULATION HAS BEEN CONTINUING FOR NEW M =    260  AND N =    250


THE NUMBER OF NODES IS    250 ENTER NEW NUMBER
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
N=   250  M=    260
TO VIEW THE TOPOGRAPHY BENEATH ANY SECTIONS
     ENTER 1, ELSE ENTER 0.

 CAUTION: IF YOUR FACILITY IS NOT GRAPHICALLY COMPATIBLE TO
TEKTRONIX MODEL 4014-1, ENTER 0
          0
MARCHED STEP=      1
MARCHED STEP=      2
MARCHED STEP=      3
   .      .      .
   .      .      .
   .      .      .
MARCHED STEP=     70
MARCHED STEP=     71
MARCHED STEP=     72
XP=     12.500 YP=    -14.998 AMPLITUDE=    0.996 DEPTH=     0.625 PHASE=     8.473
MARCHED STEP=     73
XP=     12.500 YP=    -14.748 AMPLITUDE=    0.996 DEPTH=     0.625 PHASE=     8.592
MARCHED STEP=     74
XP=     12.500 YP=    -14.497 AMPLITUDE=    0.996 DEPTH=     0.625 PHASE=     8.711
   .      .      .      .      .      .      .      .      .
   .      .      .      .      .      .      .      .      .
   .      .      .      .      .      .      .      .      .
MARCHED STEP=     99
XP=     12.500 YP=     -8.248 AMPLITUDE=    0.992 DEPTH=     0.625 PHASE=    11.668
MARCHED STEP=    100
XP=     12.500 YP=     -7.998 AMPLITUDE=    0.992 DEPTH=     0.625 PHASE=    11.787
MARCHED STEP=    101
XP=     12.500 YP=     -7.748 AMPLITUDE=    0.991 DEPTH=     0.625 PHASE=    11.905
```

```
MARCHED STEP=   102
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -7.498 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.023
MARCHED STEP=   103
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -7.248 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.141
MARCHED STEP=   104
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -6.998 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.260
   .      .       .      .      .      .      .      .      .
   .      .       .      .      .      .      .      .      .
   .      .       .      .      .      .      .      .      .
MARCHED STEP=   210
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.503 AMPLITUDE=   0.996 DEPTH=    0.625 PHASE=   25.005
MARCHED STEP=   211
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.752 AMPLITUDE=   1.000 DEPTH=    0.625 PHASE=   25.122
MARCHED STEP=   212
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.807 AMPLITUDE=   1.000 DEPTH=    0.625 PHASE=   25.147
MARCHED STEP=   213
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   214
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   215
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
   .      .       .      .      .      .      .      .      .
   .      .       .      .      .      .      .      .      .
   .      .       .      .      .      .      .      .      .
MARCHED STEP=   258
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   259
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   260
                         ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
ICOUNT =     260
FORTRAN STOP (NOTE: THIS SHOWS THE COMPLETION OF THE JOB)
$
```

(ii) SEMI-INTERACTIVE MODE

THIS MODE DOES NOT REQUIR A USER TO INPUT DATA FROM THE KEYBOARD. HOWEVER, DURING THIS SESSION OF JOB PROGRAM ALLOWS A USER TO ALTER PARAMETERS AT SEVERAL BREAKPOINTS. THIS SESSION LOOKS VERY SIMILAR TO THAT IN AN INTERACTIVE MODE BUT MUCH SIMPLIER AND EASIER. THE FOLLOWINGS ARE WHAT A USER CAN SEE ON THE SCREEN INCLUDING HIS/HER RESPONSES TO THE QUESTIONS. (NOTE: WE CHOOSE NOT TO REVIEW THE PARAMETERS.)

```
$RUN PARAWAVE


THIS IS A REMINDER!!!

HAVE YOU PREPARED FILES OF DEPTH.DAT AND LOC.DAT??
```

```
HAVE YOU PREPARED FILES OF CURRNX.DAT AND CURRNY.DAT
IF CURRENT FIELD IS  TO BE CONSIDERED??

INPUT (1-9) TO CONTINUE; 0 TO STOP

          1
WHICH MODE DO YOU WANT??

2=BATCH; FROM THIS POINT ON YOU CAN NOT ALTER ANY PARAMETERS
1=SEMI-INTERACTIVE; NO DATA INPUT FROM KEYBOARD, BUT AT
  SEVERAL BREAKPOINTS PROGRAM ALLOWS YOU TO ADJUST PARAMETERS
0=INTERACTIVE; ALL DATA INPUT FROM KEYBOARD EXCEPT DEPTH.DAT,
  LOC.DAT, AND/OR CURRNX.DAT AND CURRNY.DAT. YOU CAN ALSO
  ADJUST PARAMETERS

          1
DO YOU WISH TO REVIEW THE DEFAULT PARAMETERS?
  ENTER 1 FOR YES, 0 FOR NO

          0
DO YOU WANT TO REVIEW THE DEPTH AND CURRENT DATA?

     ENTER 1 FOR YES, 0 FOR NO
          0
 (       34.777 ,       30.149 ) IS THE FARTHEST DISTANCE FROM SHORE
WHERE CALCULATIONS CAN BE DONE FOR N=   250
WARING: MAX. N IS 500


 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0



CALCULATION HAS BEEN CONTINUING FOR M =   260  AND NEW N =   250


 (        1.447 ,      -21.708 ) IS THE CLOSEST DISTANCE FROM SHORE
WHERE CALCULATIONS CAN BE DONE FOR M=   260
WARING: MAX. M IS 1500


 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0



CALCULATION HAS BEEN CONTINUING FOR NEW M =   260  AND N =   250


THE NUMBER OF NODES IS   250 ENTER NEW NUMBER
 DO YOU WISH TO CHANGE THIS VALUE ?
     ENTER 1 FOR YES, 0 FOR NO
          0
N=   250  M=   260
TO VIEW THE TOPOGRAPHY BENEATH ANY SECTIONS
```

```
     ENTER 1, ELSE ENTER 0.

 CAUTION: IF YOUR FACILITY IS NOT GRAPHICALLY COMPATIBLE TO
TEKTRONIX MODEL 4014-1, ENTER 0
          0
MARCHED STEP=     1
MARCHED STEP=     2
MARCHED STEP=     3
   .     .        .
   .     .        .
   .     .        .
MARCHED STEP=    70
MARCHED STEP=    71
MARCHED STEP=    72
XP=    12.500 YP=   -14.998 AMPLITUDE=   0.996 DEPTH=    0.625 PHASE=    8.473
MARCHED STEP=    73
XP=    12.500 YP=   -14.748 AMPLITUDE=   0.996 DEPTH=    0.625 PHASE=    8.592
MARCHED STEP=    74
XP=    12.500 YP=   -14.497 AMPLITUDE=   0.996 DEPTH=    0.625 PHASE=    8.711
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 MARCHED STEP=    99
XP=    12.500 YP=    -8.248 AMPLITUDE=   0.992 DEPTH=    0.625 PHASE=   11.668
MARCHED STEP=   100
XP=    12.500 YP=    -7.998 AMPLITUDE=   0.992 DEPTH=    0.625 PHASE=   11.787
MARCHED STEP=   101
XP=    12.500 YP=    -7.748 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   11.905
MARCHED STEP=   102
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -7.498 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.023
MARCHED STEP=   103
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -7.248 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.141
MARCHED STEP=   104
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    -6.998 AMPLITUDE=   0.991 DEPTH=    0.625 PHASE=   12.260
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MARCHED STEP=   210
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.503 AMPLITUDE=   0.996 DEPTH=    0.625 PHASE=   25.005
MARCHED STEP=   211
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.752 AMPLITUDE=   1.000 DEPTH=    0.625 PHASE=   25.122
MARCHED STEP=   212
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
XP=    12.500 YP=    19.807 AMPLITUDE=   1.000 DEPTH=    0.625 PHASE=   25.147
MARCHED STEP=   213
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   214
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=   215
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
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MARCHED STEP=   258
                 ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
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MARCHED STEP=    259
                    ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
MARCHED STEP=    260
                    ENCOUNTERED BRKWTR NO.  1     BRKWTR ANGLE   0.000000
ICOUNT =    260
FORTRAN STOP (NOTE: THIS SHOWS THE COMPLETION OF THE JOB)
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(iii) BATCH MODE

THIS MODE DOES NOT ALLOW ANY INTERACTION BETWEEN THE PROGRAM AND A USER ONCE THE JOB IS IN PROGRESS. THS FOLLOWING ARE WHAT A USER CAN SEE ON THE SCREEN OF A TERMINAL.

```
$RUN PARAWAVE



THIS IS A REMINDER!!!

HAVE YOU PREPARED FILES OF DEPTH.DAT AND LOC.DAT??

HAVE YOU PREPARED FILES OF CURRNX.DAT AND CURRNY.DAT
IF CURRENT FIELD IS  TO BE CONSIDERED??

INPUT (1-9) TO CONTINUE; 0 TO STOP

          1
WHICH MODE DO YOU WANT??

2=BATCH; FROM THIS POINT ON YOU CAN NOT ALTER ANY PARAMETERS
1=SEMI-INTERACTIVE; NO DATA INPUT FROM KEYBOARD, BUT AT
  SEVERAL BREAKPOINTS PROGRAM ALLOWS YOU TO ADJUST PARAMETERS
0=INTERACTIVE; ALL DATA INPUT FROM KEYBOARD EXCEPT DEPTH.DAT,
  LOC.DAT, AND/OR CURRNX.DAT AND CURRNY.DAT. YOU CAN ALSO
  ADJUST PARAMETERS

          2




          PLEASE WAIT!!
          PROGRAM IS RUNNING.
**************************************************
ICOUNT =    260
FORTRAN STOP
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Appendix A

Input Data Files for Normal Incident Wave Propagating Over a Submerged Shoal

(i) DEPTH.DAT
(ii) LOC.DAT

(i) DEPTH.DAT

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0.330	0.316	0.330	0.367	0.430	0.430	0.430	0.430	0.430	0.430
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0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.342	0.282
0.246	0.234	0.246	0.282	0.342	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.367	0.282	0.222
0.187	0.176	0.187	0.222	0.282	0.367	0.430	0.430	0.430	0.430
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.330	0.246	0.187

0.153	0.141	0.153	0.187	0.246	0.330	0.430	0.430	0.430	0.430
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0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430	0.430	0.430	0.430	[illegible]	0.430	0.430	[illegible]
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	[illegible]	[illegible]

0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430							
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
0.430	0.430	0.430							

(ii) LOC.DAT

```
  1
  0.   15.    0.25
  0
-20.    0.    0.25  0.50  0.75  1.00  1.25  1.50  1.75  2.00
  2.25  2.50  2.75  3.00  3.25  3.50  3.75  4.00  4.25  4.50
  4.75  5.00 20.
```

Appendix B

Input Data Files for Obliquely Incident
Wave Propagating Over a Submerged Shoal
on a Sloping Bottom

(i) DEPTH.DAT
(ii) LOC.DAT

(i) DEPTH.DAT

```
 0
0.     0.     0.     0.     0.     0      0      0      0      0
0.     0.     0.     0.     0.     0      0      0      0      0
0.
 .02    .02    .02    .02    .02   0.02   0.02   0.02   0.02   0.02
 .02    .02    .02    .02    .02   0.02   0.02   0.02   0.02   0.02
 .02
0.1    0.1    0.1    0.1    0.1     .1     .1     .1     .1     .1
0.1    0.1    0.1    0.1    0.1     .1     .1     .1     .1     .1
0.1
 .2     .2     .2     .2     .2    0.2    0.2    0.2    0.2    0.2
 .2     .2     .2     .2     .2    0.2    0.2    0.2    0.2    0.2
 .2
0.26   0.26   0.26   0.26   0.26    .26    .26    .26    .26    .26
0.26   0.26   0.26   0.26   0.26    .26    .26    .26    .26    .26
0.26
0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803
0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803 0.2803
0.2803
0.2903 0.2903 0.2903 0.2903 0.2903 0.2903  .2758  .2491  .2313  .2210
 .2176  .2210  .2313  .2491  .2758 0.2903 0.2903 0.2903 0.2903 0.2903
0.2903
 .3003  .3003  .3003  .3003  .3003 0.2591 0.2276 0.2048 0.1893 0.1803
0.1773 0.1803 0.1893 0.2048 0.2276  .2591  .3003  .3003  .3003  .3003
 .3003
0.3103 0.3103 0.3103 0.3103 0.2639  .2262  .1982  .1773  .1631  .1548
 .1520  .1548  .1631  .1773  .1982 0.2262 0.2639 0.3103 0.3103 0.3103
0.3103
 .3203  .3203  .3203 0.2891 0.2432 0.2083 0.1819 0.1623 0.1489 0.1410
 .1384 0.1410 0.1489 0.1623 0.1819 0.2083 0.2432 0.2891  .3203  .3203
 .3203
0.3303 0.3303 0.3303  .2795  .2359  .2025  .1769  .1580  .1450  .1373
0.1348  .1373  .1450  .1580  .1769  .2025  .2359  .2795 0.3303 0.3303
0.3303
 .3403  .3403  .3403 0.2832 0.2403 0.2073 0.1820 0.1633 0.1504 0.1428
 .1403 0.1428 0.1504 0.1633 0.1820 0.2073 0.2403 0.2832  .3403  .3403
 .3403
0.3503 0.3503 0.3503  .2995  .2559  .2225  .1969  .1780  .1650  .1573
0.1548  .1573  .1650  .1780  .1969  .2225  .2559  .2995 0.3503 0.3503
0.3503
 .3603  .3603  .3603 0.3291 0.2832 0.2483 0.2219 0.2023 0.1889 0.1810
 .1784 0.1810 0.1889 0.2023 0.2219 0.2483 0.2832 0.3291  .3603  .3603
 .3603
0.3703 0.3703 0.3703 0.3703  .3239  .2862  .2580  .2373  .2231  .2148
0.2120  .2148  .2231  .2373  .2580  .2862  .3239 0.3703 0.3703 0.3703
0.3703
 .3803  .3803  .3803  .3803  .3803 0.3391 0.3076 0.2848 0.2693 0.2603
 .2573 0.2603 0.2693 0.2848 0.3076 0.3391  .3803  .3803  .3803  .3803
 .3803
0.3903 0.3903 0.3903 0.3903 0.3903 0.3903  .3758  .3491  .3313  .3210
0.3176  .3210  .3313  .3491  .3758 0.3903 0.3903 0.3903 0.3903 0.3903
0.3903
 .4003  .4003  .4003  .4003  .4003 0.4003 0.4003 0.4003 0.4003 0.4003
0.4003 0.4003 0.4003 0.4003 0.4003  .4003  .4003  .4003  .4003  .4003
 .4003
 .45    .45    .45    .45    .45   0.45   0.45   0.45   0.45   0.45
 .45    .45    .45    .45    .45   0.45   0.45   0.45   0.45   0.45
0.45
0.45   0.45   0.45   0.45    .45    .45    .45    .45    .45    .45
 .45   0.45   0.45   0.45   0.45   0.45    .45    .45    .45    .45
```

.45									
0.45	0.45	0.45	0.45	0.45	0.45	.45	.45	.45	.45
.45	0.45	0.45	0.45	0.45	0.45	.45	.45	.45	.45
.45									

(ii) LOC.DAT

```
0
0.
1.
5.
10.
13.
14.0156
14.5156
15.0156
15.5156
16.0156
16.5156
17.0156
17.5156
18.0156
18.5156
19.0156
19.5156
20.0156
22.5
25.
30.
0
-15
-10
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
10
15
```

Appendix C

Input Data Files for the CERC Field Experiments

(i) DEPTH.DAT (October 16, 1982)
(ii) DEPTH.DAT (October 27, 1982)
(iii) LOC.DAT (October 16 and 27, 1982)

(i) DEPTH.DAT (Oct. 16, 1982)

2

-6.44	-4.22	-3.19	-1.69	-0.47	1.00	1.82	1.93	1.97	2.05
2.07	1.80	1.92	2.24	2.56	2.95	3.16	3.27	3.32	3.38
3.43	3.51	3.60	3.71	3.81	3.92	4.08	4.25	4.42	4.45
4.68	4.85	5.02	5.15	5.25	5.34	5.46	5.58	5.70	5.79
5.89	5.97	6.07	6.17	6.26	6.33	6.40	6.49	6.58	6.66
6.74	6.82	6.92	7.01	7.09	7.15	7.22	7.28	7.36	7.44
7.51	7.58	7.64	7.73	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.32	8.39	8.42					
-6.52	-3.99	-3.06	-1.81	-0.70	0.97	1.86	1.87	1.89	1.96
2.03	1.75	1.93	2.26	2.56	2.95	3.16	3.26	3.31	3.37
3.42	3.50	3.60	3.71	3.80	3.91	4.07	4.25	4.42	4.55
4.67	4.84	5.01	5.14	5.24	5.33	5.45	5.58	5.70	5.79
5.88	5.96	6.06	6.17	6.26	6.32	6.39	6.48	6.57	6.66
6.74	6.81	6.91	7.01	7.09	7.15	7.22	7.28	7.37	7.44
7.52	7.58	7.64	7.73	7.81	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.39	8.43					
-6.41	-3.93	-3.08	-1.88	-0.85	0.79	1.84	1.76	1.74	1.74
1.81	1.70	1.97	2.28	2.57	2.92	3.13	3.23	3.29	3.35
3.41	3.49	3.59	3.70	3.80	3.90	4.06	4.24	4.41	4.53
4.65	4.81	4.98	5.12	5.22	5.32	5.44	5.56	5.68	5.77
5.86	5.94	6.04	6.15	6.24	6.31	6.38	6.47	6.57	6.65
6.73	6.80	6.90	7.00	7.08	7.15	7.22	7.29	7.37	7.45
7.52	7.58	7.64	7.73	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.39	8.44					
-6.24	-3.87	-3.11	-2.07	-0.97	0.61	1.81	1.63	1.55	1.50
1.56	1.66	2.01	2.31	2.59	2.90	3.09	3.21	3.27	3.34
3.39	3.48	3.58	3.69	3.79	3.89	4.05	4.23	4.40	4.51
4.63	4.79	4.95	5.09	5.20	5.30	5.43	5.55	5.66	5.74
5.83	5.91	6.02	6.13	6.23	6.30	6.37	6.46	6.56	6.65
6.72	6.79	6.88	6.99	7.08	7.15	7.22	7.29	7.38	7.46
7.53	7.58	7.64	7.72	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.38	8.45					
-6.01	-3.79	-3.20	-2.22	-1.04	0.55	1.80	1.50	1.40	1.30
1.33	1.62	2.04	2.33	2.60	2.88	3.06	3.18	3.25	3.32
3.37	3.46	3.57	3.68	3.77	3.88	4.04	4.22	4.37	4.49
4.61	4.76	4.92	5.07	5.18	5.28	5.42	5.53	5.64	5.72
5.81	5.89	6.00	6.11	6.21	6.28	6.35	6.45	6.55	6.64
6.71	6.78	6.87	6.98	7.08	7.15	7.22	7.29	7.38	7.46
7.53	7.58	7.64	7.72	7.80	7.87	7.92	7.98	8.04	8.12
8.20	8.25	8.30	8.38	8.46					
-5.92	-4.00	-3.22	-2.23	-1.12	0.42	1.66	1.49	1.34	1.24
1.34	1.63	2.04	2.34	2.61	2.89	3.07	3.19	3.25	3.31
3.36	3.44	3.54	3.64	3.74	3.84	3.99	4.16	4.33	4.45
4.56	4.71	4.87	5.03	5.14	5.25	5.38	5.50	5.61	5.70
5.79	5.87	5.98	6.09	6.20	6.27	6.34	6.44	6.54	6.63
6.70	6.77	6.87	6.98	7.08	7.15	7.22	7.29	7.38	7.46
7.54	7.59	7.64	7.72	7.80	7.87	7.93	7.98	8.04	8.12
8.19	8.25	8.30	8.37	8.44					
-6.08	-4.09	-3.26	-2.24	-1.22	0.32	1.66	1.44	1.30	1.23
1.34	1.62	2.04	2.34	2.61	2.89	3.08	3.19	3.25	3.31
3.35	3.41	3.50	3.60	3.69	3.80	3.95	4.12	4.28	4.40
4.52	4.67	4.83	4.99	5.10	5.21	5.35	5.48	5.59	5.67
5.77	5.85	5.97	6.08	6.18	6.26	6.33	6.43	6.53	6.63
6.70	6.77	6.87	6.98	7.08	7.15	7.22	7.29	7.38	7.46
7.54	7.59	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
8.19	8.25	8.29	8.36	8.43					
-6.37	-4.17	-3.32	-2.26	-1.33	0.23	1.71	1.39	1.28	1.22
1.34	1.62	2.04	2.34	2.61	2.91	3.10	3.21	3.25	3.30
3.33	3.39	3.46	3.56	3.65	3.74	3.89	4.06	4.23	4.34

4.46	4.62	4.78	4.94	5.06	5.17	5.31	5.44	5.56	5.65
5.75	5.83	5.95	6.06	6.17	6.24	6.32	6.42	6.53	6.62
6.70	6.76	6.86	6.98	7.08	7.15	7.23	7.29	7.38	7.47
7.54	7.59	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
8.19	8.24	8.29	8.34	8.42					
-6.44	-4.29	-3.39	-2.32	-1.39	0.17	1.66	1.36	1.26	1.22
1.36	1.63	2.03	2.34	2.62	2.92	3.12	3.22	3.26	3.29
3.32	3.36	3.43	3.51	3.60	3.69	3.83	4.00	4.17	4.29
4.41	4.56	4.73	4.90	5.02	5.13	5.28	5.41	5.54	5.63
5.72	5.81	5.93	6.05	6.15	6.23	6.31	6.41	6.52	6.62
6.69	6.76	6.86	6.98	7.08	7.15	7.23	7.30	7.38	7.47
7.54	7.60	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
8.19	8.24	8.28	8.33	8.40					
-6.39	-4.43	-3.46	-2.38	-1.45	0.12	1.56	1.33	1.23	1.21
1.38	1.63	2.02	2.34	2.62	2.93	3.13	3.23	3.26	3.29
3.30	3.33	3.39	3.47	3.55	3.65	3.78	3.95	4.11	4.23
4.35	4.51	4.68	4.85	4.98	5.09	5.24	5.38	5.51	5.60
5.70	5.79	5.91	6.03	6.14	6.21	6.29	6.40	6.51	6.61
6.69	6.76	6.86	6.98	7.08	7.15	7.23	7.30	7.38	7.47
7.55	7.60	7.65	7.73	7.80	7.88	7.93	7.98	8.04	8.12
8.18	8.24	8.28	8.32	8.39					
-6.56	-4.49	-3.51	-2.43	-1.49	0.07	1.56	1.29	1.21	1.21
1.39	1.63	2.02	2.34	2.63	2.94	3.14	3.24	3.26	3.28
3.29	3.31	3.36	3.43	3.51	3.60	3.74	3.90	4.07	4.19
4.31	4.47	4.64	4.81	4.94	5.06	5.21	5.36	5.49	5.58
5.68	5.77	5.89	6.01	6.12	6.20	6.28	6.39	6.51	6.61
6.69	6.76	6.86	6.97	7.08	7.15	7.23	7.30	7.38	7.47
7.55	7.60	7.65	7.73	7.81	7.88	7.93	7.98	8.04	8.12
8.18	8.24	8.27	8.31	8.38					
-6.83	-4.53	-3.52	-2.49	-1.53	-0.01	1.61	1.21	1.18	1.22
1.40	1.63	2.03	2.35	2.63	2.95	3.16	3.25	3.27	3.28
3.28	3.28	3.32	3.39	3.47	3.55	3.68	3.84	4.01	4.14
4.26	4.41	4.59	4.77	4.90	5.02	5.17	5.32	5.47	5.56
5.66	5.75	5.87	6.00	6.11	6.19	6.28	6.38	6.50	6.61
6.69	6.76	6.86	6.98	7.08	7.16	7.24	7.30	7.38	7.47
7.55	7.60	7.66	7.73	7.81	7.89	7.93	7.98	8.04	8.12
8.18	8.23	8.27	8.29	8.37					
-6.79	-4.62	-3.53	-2.50	-1.51	0.04	1.56	1.20	1.18	1.24
1.43	1.68	2.07	2.38	2.67	2.99	3.19	3.27	3.29	3.30
3.29	3.29	3.31	3.37	3.44	3.51	3.64	3.79	3.96	4.09
4.21	4.37	4.56	4.74	4.88	5.00	5.15	5.31	5.45	5.56
5.66	5.75	5.88	6.00	6.12	6.20	6.29	6.40	6.52	6.63
6.71	6.78	6.88	6.99	7.10	7.17	7.25	7.31	7.39	7.48
7.56	7.61	7.66	7.73	7.81	7.89	7.93	7.98	8.04	8.11
8.18	8.23	8.26	8.28	8.35					
-6.63	-4.69	-3.57	-2.43	-1.45	0.16	1.52	1.24	1.20	1.26
1.49	1.76	2.15	2.46	2.74	3.04	3.22	3.31	3.33	3.33
3.33	3.32	3.33	3.37	3.42	3.49	3.60	3.75	3.92	4.05
4.17	4.34	4.53	4.72	4.86	4.98	5.14	5.31	5.46	5.56
5.67	5.77	5.90	6.03	6.15	6.24	6.32	6.44	6.56	6.67
6.75	6.82	6.91	7.02	7.12	7.20	7.27	7.33	7.41	7.49
7.57	7.62	7.67	7.74	7.81	7.89	7.93	7.98	8.04	8.11
8.17	8.22	8.25	8.27	8.34					
-6.61	-4.72	-3.56	-2.38	-1.40	0.25	1.57	1.25	1.22	1.30
1.54	1.84	2.22	2.52	2.80	3.08	3.26	3.34	3.36	3.37
3.36	3.35	3.35	3.37	3.41	3.46	3.57	3.71	3.88	4.01
4.14	4.32	4.52	4.71	4.85	4.98	5.14	5.31	5.46	5.57
5.69	5.79	5.92	6.06	6.18	6.27	6.36	6.47	6.60	6.71
6.78	6.85	6.95	7.05	7.15	7.22	7.29	7.35	7.42	7.50
7.58	7.63	7.68	7.74	7.81	7.88	7.93	7.98	8.04	8.10

8.17	8.21	8.24	8.27	8.33					
-6.69	-4.72	-3.53	-2.32	-1.32	0.38	1.65	1.25	1.25	1.33
1.60	1.92	2.32	2.61	2.87	3.14	3.30	3.38	3.40	3.41
3.40	3.38	3.37	3.38	3.40	3.44	3.53	3.67	3.84	3.98
4.11	4.29	4.50	4.69	4.84	4.97	5.13	5.31	5.47	5.59
5.71	5.81	5.95	6.09	6.22	6.31	6.40	6.51	6.64	6.75
6.83	6.90	6.98	7.08	7.18	7.24	7.31	7.37	7.44	7.51
7.59	7.64	7.69	7.75	7.82	7.89	7.93	7.98	8.04	8.10
8.17	8.20	8.22	8.25	8.32					
-6.68	-4.68	-3.41	-2.26	-1.21	0.53	1.69	1.29	1.27	1.37
1.69	2.02	2.41	2.69	2.94	3.20	3.34	3.43	3.45	3.46
3.45	3.42	3.39	3.38	3.39	3.41	3.49	3.63	3.81	3.94
4.07	4.26	4.47	4.68	4.83	4.96	5.13	5.31	5.48	5.60
5.73	5.84	5.98	6.13	6.26	6.35	6.44	6.56	6.69	6.80
6.87	6.94	7.02	7.11	7.20	7.27	7.34	7.39	7.46	7.53
7.60	7.65	7.69	7.75	7.82	7.88	7.93	7.98	8.04	8.09
8.17	8.19	8.21	8.24	8.31					
-6.52	-4.66	-3.33	-2.25	-1.11	0.68	1.78	1.19	1.32	1.41
1.71	2.10	2.49	2.78	3.03	3.27	3.40	3.49	3.52	3.51
3.49	3.46	3.41	3.38	3.38	3.39	3.46	3.60	3.79	3.93
4.07	4.25	4.46	4.69	4.85	4.99	5.15	5.32	5.51	5.65
5.78	5.88	6.01	6.17	6.31	6.40	6.49	6.60	6.73	6.85
6.92	6.99	7.06	7.14	7.23	7.30	7.36	7.42	7.48	7.54
7.61	7.65	7.70	7.76	7.82	7.89	7.93	7.98	8.04	8.09
8.16	8.19	8.21	8.24	8.30					
-6.39	-4.67	-3.37	-2.21	-1.12	0.57	1.63	1.45	1.44	1.52
1.74	2.13	2.57	2.88	3.17	3.46	3.63	3.67	3.65	3.61
3.55	3.47	3.40	3.37	3.38	3.39	3.49	3.65	3.84	3.99
4.14	4.35	4.58	4.80	4.96	5.10	5.28	5.48	5.65	5.77
5.89	6.00	6.14	6.28	6.40	6.48	6.57	6.69	6.80	6.91
6.98	7.04	7.11	7.19	7.26	7.32	7.38	7.44	7.50	7.56
7.62	7.66	7.71	7.77	7.83	7.89	7.93	7.98	8.04	8.09
8.17	8.20	8.22	8.26	8.32					
-6.31	-4.65	-3.39	-2.21	-1.15	0.47	1.60	1.63	1.63	1.65
1.76	2.15	2.64	3.00	3.33	3.69	3.88	3.88	3.81	3.72
3.62	3.47	3.38	3.35	3.37	3.40	3.53	3.72	3.93	4.09
4.25	4.47	4.71	4.94	5.11	5.26	4.45	5.64	5.81	5.93
6.05	6.15	6.27	6.40	6.51	6.59	6.67	6.77	6.88	6.98
7.04	7.10	7.16	7.23	7.30	7.35	7.41	7.45	7.52	7.58
7.63	7.67	7.71	7.77	7.83	7.89	7.94	7.98	8.04	8.10
8.18	8.22	8.25	8.29	8.34					
-6.28	-4.57	-3.32	-2.23	-1.24	0.38	1.59	1.80	1.80	1.78
1.77	2.17	2.71	3.11	3.49	3.91	4.13	4.10	3.98	3.84
3.69	3.48	3.37	3.34	3.38	3.43	3.58	3.80	4.02	4.20
4.37	4.59	4.84	5.09	5.27	5.43	5.63	5.81	5.98	6.10
6.22	6.31	6.41	6.52	6.63	6.70	6.77	6.86	6.96	7.05
7.10	7.15	7.21	7.27	7.33	7.38	7.43	7.47	7.54	7.59
7.64	7.67	7.71	7.78	7.84	7.90	7.94	7.98	8.04	8.11
8.19	8.23	8.27	8.31	8.36					
-6.27	-4.46	-3.07	-2.24	-1.04	0.30	1.61	1.90	1.90	1.84
1.77	2.20	2.80	3.23	3.62	4.11	4.40	4.30	4.17	4.03
3.84	3.51	3.45	3.50	3.56	3.58	3.67	3.92	4.19	4.38
4.55	4.76	5.01	5.31	5.52	5.68	5.85	6.00	6.22	6.36
6.47	6.52	6.58	6.69	6.81	6.87	6.91	6.96	7.05	7.13
7.17	7.21	7.26	7.31	7.36	7.40	7.44	7.49	7.56	7.61
7.64	7.67	7.71	7.78	7.84	7.90	7.94	7.98	8.04	8.11
8.20	8.24	8.29	8.34	8.38					
-6.20	-4.51	-3.26	-2.24	-1.37	-0.08	1.28	1.66	1.72	1.76
1.83	2.37	2.96	3.36	3.72	4.16	4.47	4.47	4.43	4.36
4.24	4.09	4.08	4.05	4.07	4.11	4.22	4.38	4.55	4.72

4.88	5.13	5.43	5.74	5.93	6.08	6.28	6.50	6.71	6.79
6.87	6.93	7.01	7.11	7.16	7.17	7.17	7.18	7.21	7.23
7.25	7.27	7.31	7.34	7.38	7.41	7.44	7.48	7.54	7.59
7.63	7.66	7.70	7.76	7.83	7.89	7.93	7.97	8.03	8.10
8.19	8.24	8.29	8.34	8.38					
-6.03	-4.61	-3.29	-2.20	-1.45	-0.37	0.95	1.38	1.50	1.65
1.95	2.57	3.13	3.52	3.81	4.19	4.49	4.59	4.64	4.67
4.66	4.61	4.66	4.60	4.58	4.61	4.68	4.77	4.87	5.01
5.17	5.42	5.76	6.10	6.28	6.43	6.65	6.90	7.13	7.17
7.23	7.29	7.36	7.46	7.47	7.42	7.39	7.35	7.33	7.31
7.31	7.32	7.33	7.36	7.39	7.41	7.44	7.47	7.52	7.57
7.61	7.64	7.68	7.75	7.82	7.88	7.92	7.97	8.03	8.09
8.17	8.24	8.29	8.34	8.38					
-6.11	-4.68	-3.28	-2.19	-1.55	-0.61	0.89	1.17	1.33	1.54
1.95	2.76	3.28	3.63	3.87	4.20	4.53	4.67	4.81	4.92
4.99	5.00	5.09	5.02	5.02	5.00	5.03	5,05	5.12	5.27
5.39	5.61	6.02	6.38	6.55	6.70	6.92	7.21	7.43	7.47
7.53	7.55	7.63	7.65	7.45	7.27	7.40	7.48	7.42	7.37
7.36	7.34	7.35	7.38	7.39	7.41	7.44	7.46	7.51	7.55
7.59	7.63	7.66	7.73	7.81	7.87	7.91	7.96	8.02	8.08
8.17	8.23	8.29	8.35	8.39					
-5.90	-5.23	-3.15	-2.22	-1.56	-0.98	0.50	0.96	1.19	1.41
1.94	2.78	3.22	3.54	3.76	4.14	4.60	4.72	4.91	5.02
5.20	5.60	5.68	5.36	5.37	5.45	5.66	5.57	5.42	5.53
5.67	6.05	6.51	6.74	6.88	7.04	7.30	7.78	7.91	7.74
7.82	7.92	8.13	8.08	7.20	4.49	7.46	7.72	7.60	7.44
7.38	7.37	7.38	7.41	7.41	7.41	7.43	7.44	7.49	7.54
7.58	7.61	7.66	7.72	7.79	7.85	7.90	7.94	8.00	8.07
8.16	8.22	8.27	8.33	8.37					
-6.08	-4.72	-3.28	-2.14	-1.44	0.62	0.45	0.86	1.06	1.35
1.86	2.54	3.01	3.31	3.51	3.77	4.06	4.34	4.49	4.62
4.70	4.80	4.93	4.66	4.77	4.85	4.96	5.01	5.09	5.23
5.39	5.67	6.02	6.35	6.53	6.68	6.86	7.13	7.36	7.38
7.43	7.44	7.51	7.55	7.31	7.05	7.30	7.40	7.34	7.29
7.27	7.26	7.27	7.30	7.34	7.36	7.38	7.39	7.43	7.50
7.55	7.59	7.63	7.69	7.77	7.83	7.88	7.93	7.99	8.06
8.14	8.21	8.27	8.33	8.37					
-6.19	-4.72	-3.25	-2.08	-1.34	-0.44	0.46	0.89	1.04	1.33
1.80	2.33	2.77	3.06	3.22	3.42	3.65	3.93	4.02	4.09
4.13	4.17	4.26	4.18	4.24	4.31	4.43	4.57	4.75	4.92
5.08	5.34	5.64	5.95	6.12	6.27	6.44	6.64	6.86	6.92
6.98	7.01	7.05	7.11	7.11	7.08	7.10	7.14	7.14	7.14
7.14	7.15	7.17	7.22	7.27	7.31	7.33	7.35	7.39	7.46
7.52	7.56	7.61	7.67	7.75	7.82	7.87	7.92	7.98	8.05
8.13	8.20	8.26	8.33	8.37					
-6.43	-4.74	-3.13	-1.97	-1.02	-0.08	0.54	0.91	1.07	1.34
1.72	2.09	2.47	2.71	2.87	3.00	3.15	3.36	3.45	3.48
3.44	3.46	3.55	3.63	3.72	3.79	3.96	4.18	4.41	4.60
4.77	5.01	5.28	5.52	5.68	5.82	5.97	6.15	6.31	6.40
6.47	6.51	6.56	6.66	6.75	6.80	6.83	6.86	6.92	6.95
6.98	7.00	7.04	7.12	7.20	7.24	7.27	7.29	7.34	7.41
7.48	7.53	7.58	7.65	7.73	7.80	7.85	7.90	7.97	8.04
8.12	8.19	8.26	8.32	8.35					
-6.57	-4.82	-3.08	-1.87	-0.85	0.20	0.59	0.90	1.08	1.35
1.72	2.07	2.46	2.69	2.86	3.00	3.10	3.27	3.31	3.32
3.28	3.25	3.28	3.36	3.45	3.52	3.69	3.94	4.20	4.39
4.55	4.78	5.01	5.23	5.38	5.50	5.64	5.80	5.94	6.04
6.11	6.16	6.23	6.34	6.45	6.53	6.59	6.67	6.75	6.82
6.87	6.90	6.97	7.05	7.13	7.18	7.22	7.26	7.32	7.40
7.47	7.51	7.56	7.64	7.72	7.79	7.84	7.90	7.97	8.04

8.12	8.19	8.25	8.32	8.36					
-6.57	-4.78	-3.07	-1.58	-0.35	0.42	0.59	0.85	1.07	1.37
1.78	2.23	2.65	2.89	3.11	3.33	3.46	3.51	3.51	3.51
3.53	3.51	3.42	3.40	3.45	3.53	3.69	3.91	4.14	4.30
4.47	4.68	4.89	5.08	5.22	5.34	5.48	5.62	5.77	5.86
5.95	6.02	6.11	6.22	6.33	6.41	6.48	6.57	6.66	6.75
6.80	6.86	6.93	7.01	7.09	7.14	7.20	7.25	7.33	7.41
7.47	7.52	7.57	7.64	7.72	7.79	7.84	7.90	7.98	8.06
8.13	8.19	8.25	8.32	8.37					
-6.61	-4.70	-3.14	-1.60	-0.35	0.57	0.66	0.89	1.10	1.38
1.77	2.27	2.72	2.99	3.23	3.45	3.56	3.62	3.63	3.64
3.64	3.60	3.52	3.49	3.52	3.58	3.72	3.91	4.12	4.27
4.42	4.62	4.82	5.00	5.13	5.24	5.39	5.53	5.67	5.77
5.86	5.93	6.04	6.15	6.26	6.33	6.41	6.51	6.61	6.70
6.76	6.82	6.90	6.99	7.06	7.12	7.18	7.24	7.32	7.40
7.46	7.51	7.56	7.64	7.71	7.78	7.84	7.90	7.98	8.06
8.13	8.18	8.23	8.31	8.36					
-6.75	-4.56	-3.08	-1.55	-0.32	0.81	0.72	0.89	1.12	1.38
1.73	2.25	2.71	2.99	3.24	3.46	3.57	3.64	3.66	3.67
3.66	3.62	3.57	3.55	3.58	3.62	3.75	3.93	4.11	4.25
4.39	4.57	4.77	4.94	5.06	5.17	5.32	5.46	5.60	5.69
5.79	5.87	5.98	6.10	6.20	6.27	6.35	6.46	6.57	6.66
6.72	6.78	6.86	6.96	7.05	7.10	7.17	7.23	7.31	7.39
7.45	7.50	7.55	7.63	7.70	7.78	7.83	7.89	7.97	8.05
8.12	8.16	8.20	8.28	8.33					
-6.95	-4.37	-3.01	-1.49	-0.24	1.09	0.78	0.83	1.14	1.40
1.67	2.24	2.68	2.97	3.23	3.46	3.57	3.63	3.66	3.67
3.67	3.64	3.61	3.61	3.63	3.67	3.79	3.94	4.11	4.24
4.34	4.53	4.71	4.88	5.00	5.11	5.25	5.40	5.54	5.63
5.73	5.81	5.93	6.05	6.14	6.22	6.30	6.42	6.52	6.62
6.68	6.74	6.83	6.93	7.03	7.09	7.16	7.22	7.30	7.38
7.44	7.49	7.55	7.62	7.69	7.77	7.83	7.89	7.96	8.04
8.11	8.14	8.18	8.25	8.30					
-7.16	-4.20	-2.96	-1.33	-0.13	1.36	0.75	1.00	1.19	1.40
1.59	2.23	2.65	2.95	3.20	3.45	3.56	3.63	3.64	3.66
3.66	3.65	3.64	3.65	3.67	3.71	3.82	3.96	4.11	4.22
4.34	4.49	4.66	4.83	4.95	5.06	5.20	5.33	5.48	5.58
5.68	5.76	5.88	5.99	6.09	6.17	6.26	6.37	6.48	6.58
6.65	6.71	6.79	6.91	7.01	7.07	7.14	7.20	7.28	7.36
7.43	7.48	7.54	7.61	7.68	7.76	7.82	7.88	7.95	8.03
8.10	8.12	8.16	8.23	8.27					
-6.98	-4.05	-2.95	-1.52	-0.31	1.31	0.83	1.37	1.20	1.38
1.61	2.18	2.62	2.91	3.17	3.40	3.53	3.60	3.62	3.63
3.64	3.63	3.63	3.66	3.69	3.72	3.84	3.97	4.11	4.23
4.34	4.49	4.66	4.81	4.93	5.04	5.18	5.32	5.46	5.55
5.65	5.74	5.86	5.98	6.07	6.15	6.23	6.35	6.46	6.56
6.63	6.69	6.78	6.89	7.00	7.06	7.13	7.19	7.28	7.36
7.43	7.48	7.54	7.61	7.68	7.76	7.82	7.88	7.95	8.03
8.10	8.13	8.17	8.24	8.27					
-6.69	-3.93	-2.98	-1.71	-0.50	1.18	0.82	1.29	1.17	1.35
1.61	2.14	2.58	2.87	3.13	3.36	3.49	3.56	3.58	3.60
3.61	3.61	3.62	3.65	3.69	3.73	3.85	3.99	4.12	4.23
4.34	4.49	4.66	4.81	4.92	5.03	5.17	5.31	5.45	5.54
5.64	5.72	5.84	5.96	6.06	6.14	6.22	6.33	6.45	6.55
6.62	6.68	6.77	6.88	6.98	7.05	7.12	7.18	7.27	7.35
7.42	7.48	7.54	7.61	7.68	7.75	7.81	7.87	7.94	8.02
8.09	8.14	8.18	8.25	8.27					
-6.31	-3.84	-3.02	-1.84	-0.60	1.00	0.77	0.92	1.12	1.32
1.62	2.09	2.54	2.83	3.09	3.31	3.46	3.53	3.55	3.57
3.59	3.59	3.60	3.65	3.69	3.74	3.86	4.00	4.13	4.24

4.35	4.49	4.65	4.81	4.92	5.03	5.17	5.30	5.44	5.53
5.63	5.71	5.83	5.95	6.05	6.13	6.21	6.32	6.44	6.53
6.60	6.67	6.76	6.86	6.96	7.03	7.11	7.18	7.26	7.34
7.42	7.48	7.54	7.62	7.69	7.75	7.81	7.86	7.94	8.01
8.09	8.14	8.19	8.25	8.27					
-6.00	-3.85	-3.03	-1.92	-0.64	0.85	0.77	0.89	1.12	1.31
1.62	2.05	2.51	2.79	3.05	3.27	3.42	3.49	3.52	3.54
3.56	3.57	3.59	3.64	3.69	3.74	3.86	4.01	4.14	4.25
4.35	4.50	4.65	4.81	4.92	5.02	5.16	5.30	5.43	5.52
5.62	5.71	5.82	5.94	6.05	6.12	6.20	6.31	6.43	6.52
6.60	6.66	6.75	6.85	6.96	7.02	7.10	7.17	7.26	7.34
7.42	7.47	7.54	7.61	7.68	7.75	7.80	7.86	7.93	8.00
8.09	8.14	8.20	8.26	8.27					
-6.22	-4.03	-3.11	-1.92	-0.82	0.84	0.87	1.04	1.17	1.34
1.60	2.02	2.47	2.76	3.01	3.23	3.39	3.46	3.49	3.52
3.54	3.55	3.58	3.64	3.69	3.75	3.87	4.01	4.15	4.25
4.36	4.50	4.66	4.81	4.92	5.03	5.16	5.30	5.43	5.53
5.62	5.71	5.83	5.95	6.05	6.13	6.20	6.31	6.43	6.52
6.59	6.66	6.75	6.85	6.95	7.02	7.10	7.16	7.25	7.33
7.41	7.47	7.53	7.61	7.68	7.74	7.80	7.85	7.92	8.00
8.08	8.14	8.19	8.25	8.27					
-6.38	-4.25	-3.19	-1.99	-0.94	0.82	0.96	1.16	1.25	1.38
1.57	1.97	2.44	2.73	2.97	3.19	3.36	3.43	3.46	3.49
3.51	3.54	3.57	3.63	3.69	3.75	3.87	4.02	4.16	4.26
4.36	4.50	4.66	4.81	4.93	5.03	5.17	5.31	5.44	5.53
5.63	5.72	5.83	5.95	6.06	6.13	6.21	6.32	6.43	6.52
6.59	6.66	6.75	6.85	6.95	7.02	7.09	7.16	7.24	7.33
7.41	7.46	7.52	7.60	7.67	7.74	7.79	7.84	7.91	7.99
8.07	8.13	8.18	8.24	8.27					
-6.26	-4.49	-3.28	-2.06	-1.04	0.64	1.04	1.15	1.29	1.42
1.56	1.93	2.40	2.69	2.94	3.15	3.32	3.39	3.43	3.46
3.49	3.52	3.56	3.62	3.68	3.75	3.87	4.02	4.16	4.26
4.37	4.51	4.66	4.82	4.93	5.04	5.17	5.31	5.44	5.54
5.64	5.72	5.84	5.96	6.06	6.14	6.22	6.32	6.43	6.52
6.59	6.66	6.74	6.85	6.94	7.01	7.09	7.15	7.24	7.33
7.40	7.46	7.52	7.59	7.66	7.73	7.79	7.84	7.91	7.98
8.06	8.12	8.17	8.23	8.27					
-6.17	-4.69	-3.36	-2.14	-1.14	0.50	1.08	1.00	1.30	1.44
1.55	1.90	2.36	2.66	2.91	3.11	3.28	3.36	3.40	3.43
3.46	3.50	3.55	3.62	3.68	3.75	3.88	4.02	4.16	4.27
4.37	4.51	4.67	4.82	4.94	5.04	5.17	5.32	5.45	5.54
5.64	5.73	5.85	5.96	6.07	6.14	6.22	6.33	6.43	6.52
6.59	6.65	6.74	6.84	6.94	7.01	7.08	7.15	7.23	7.32
7.40	7.45	7.51	7.58	7.65	7.73	7.78	7.83	7.90	7.98
8.06	8.11	8.16	8.22	8.26					
-6.22	-4.87	-3.45	-2.20	-1.26	0.44	1.19	0.91	1.37	1.47
1.52	1.86	2.33	2.62	2.87	3.08	3.25	3.33	3.37	3.41
3.44	3.48	3.54	3.61	3.68	3.75	3.88	4.03	4.17	4.27
4.37	4.51	4.67	4.83	4.94	5.05	5.18	5.32	5.45	5.55
5.65	5.74	5.85	5.97	6.08	6.15	6.23	6.33	6.43	6.53
6.59	6.65	6.74	6.84	6.94	7.01	7.08	7.15	7.23	7.32
7.39	7.45	7.50	7.57	7.65	7.72	7.77	7.82	7.89	7.97
8.05	8.10	8.15	8.21	8.26					
-6.25	-5.04	-3.59	-2.36	-1.37	0.34	1.33	1.39	1.48	1.51
1.49	1.81	2.29	2.57	2.83	3.03	3.22	3.30	3.34	3.38
3.42	3.47	3.53	3.61	3.68	3.75	3.88	4.03	4.18	4.28
4.38	4.51	4.67	4.83	4.95	5.05	5.18	5.32	5.46	5.56
5.66	5.74	5.86	5.98	6.08	6.16	6.23	6.33	6.44	6.53
6.59	6.65	6.74	6.84	6.94	7.00	7.08	7.14	7.22	7.32
7.39	7.44	7.49	7.56	7.64	7.72	7.77	7.82	7.88	7.96

8.04	8.10	8.14	8.20	8.27					
-6.10	-5.16	-3.29	-2.39	-1.37	0.20	1.42	1.65	1.60	1.55
1.50	1.78	2.20	2.53	2.79	3.00	3.18	3.27	3.31	3.36
3.39	3.45	3.52	3.60	3.67	3.75	3.88	4.04	4.18	4.28
4.38	4.52	4.68	4.84	4.95	5.05	5.18	5.33	5.46	5.56
5.66	5.75	5.86	5.98	6.09	6.16	6.24	6.34	6.44	6.53
6.59	6.65	6.74	6.84	6.93	7.00	7.07	7.14	7.21	7.31
7.39	7.44	7.49	7.55	7.63	7.71	7.76	7.81	7.88	7.96
8.03	8.09	8.13	8.19	8.26					
-6.06	-5.04	-3.65	-2.44	-1.48	0.12	1.37	1.63	1.67	1.66
1.59	1.73	2.16	2.47	2.75	2.98	3.17	3.26	3.31	3.35
3.39	3.44	3.51	3.60	3.67	3.75	3.87	4.02	4.17	4.27
4.38	4.52	4.68	4.83	4.95	5.05	5.18	5.32	5.46	5.56
5.66	5.75	5.86	5.98	6.09	6.16	6.24	6.33	6.43	6.52
6.59	6.65	6.74	6.84	6.93	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.54	7.62	7.70	7.75	7.80	7.87	7.95
8.03	8.08	8.13	8.19	8.25					
-6.06	-4.90	-3.57	-2.43	-1.49	0.06	1.32	1.57	1.73	1.80
1.70	1.68	2.07	2.40	2.71	2.97	3.17	3.26	3.31	3.35
3.39	3.44	3.51	3.59	3.66	3.74	3.86	4.01	4.16	4.26
4.37	4.51	4.68	4.83	4.95	5.05	5.18	5.32	5.46	5.55
5.65	5.74	5.86	5.98	6.08	6.16	6.23	6.33	6.42	6.52
6.59	6.65	6.74	6.84	6.94	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.54	7.62	7.69	7.75	7.80	7.87	7.95
8.02	8.07	8.12	8.18	8.24					
-6.10	-4.72	-3.45	-2.40	-1.50	-0.02	1.29	1.65	1.79	1.94
1.80	1.61	1.98	2.34	2.67	2.97	3.17	3.26	3.31	3.36
3.39	3.43	3.51	3.59	3.66	3.73	3.85	4.00	4.14	4.25
4.36	4.51	4.68	4.83	4.94	5.04	5.17	5.32	5.45	5.55
5.65	5.74	5.85	5.97	6.08	6.15	6.23	6.32	6.42	6.51
6.59	6.65	6.75	6.85	6.94	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.53	7.61	7.69	7.74	7.79	7.87	7.95
8.01	8.06	8.11	8.17	8.24					
-6.14	-4.50	-3.14	-2.44	-1.46	-0.17	1.24	1.68	1.82	2.05
1.93	1.49	1.92	2.31	2.63	2.96	3.17	3.26	3.31	3.36
3.39	3.42	3.51	3.59	3.65	3.73	3.84	3.99	4.14	4.24
4.35	4.50	4.68	4.83	4.94	5.04	5.17	5.32	5.45	5.55
5.65	5.73	5.85	5.97	6.08	6.15	6.22	6.31	6.41	6.51
6.58	6.65	6.75	6.85	6.94	7.00	7.07	7.12	7.20	7.31
7.39	7.44	7.48	7.53	7.60	7.68	7.74	7.79	7.86	7.94
8.01	8.06	8.10	8.16	8.23					

(ii) DEPTH.DAT (Oct. 27, 1982)

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-6.49	-4.81	-3.30	-1.76	-0.75	1.19	2.31	2.42	2.29	2.12
1.74	1.51	1.80	2.19	2.58	3.07	3.42	3.60	3.65	3.68
3.67	3.64	3.64	3.68	3.73	3.79	3.90	4.04	4.20	4.34
4.48	4.67	4.85	5.01	5.13	5.23	5.37	5.51	5.65	5.75
5.86	5.97	6.09	6.21	6.31	6.39	6.46	6.56	6.66	6.75
6.82	6.89	6.98	7.07	7.15	7.14	7.18	7.28	7.36	7.44
7.51	7.58	7.64	7.73	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.32	8.39	8.42					
-6.55	-4.34	-3.24	-1.90	-0.80	1.17	2.30	2.39	2.25	2.07
1.67	1.45	1.79	2.19	2.58	3.07	3.44	3.61	3.66	3.68
3.67	3.63	3.64	3.67	3.72	3.78	3.89	4.04	4.20	4.34
4.48	4.66	4.85	5.01	5.13	5.23	5.37	5.51	5.65	5.75
5.86	5.96	6.09	6.21	6.31	6.38	6.46	6.55	6.66	6.75
6.81	6.88	6.97	7.07	7.11	7.12	7.18	7.28	7.37	7.44
7.52	7.58	7.64	7.73	7.81	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.39	8.43					
-6.44	-4.17	-3.28	-2.02	-0.92	0.94	2.22	2.31	2.14	1.93
1.53	1.42	1.79	2.19	2.58	3.07	3.45	3.61	3.65	3.67
3.66	3.62	3.62	3.66	3.71	3.77	3.89	4.04	4.21	4.34
4.47	4.65	4.84	5.00	5.12	5.22	5.36	5.50	5.64	5.74
5.85	5.94	6.07	6.19	6.29	6.37	6.45	6.55	6.65	6.73
6.80	6.87	6.96	7.06	7.07	7.08	7.18	7.29	7.37	7.45
7.52	7.58	7.64	7.73	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.39	8.44					
-6.26	-4.24	-3.44	-2.27	-1.15	0.68	2.13	2.21	2.02	1.79
1.37	1.40	1.79	2.18	2.56	3.07	3.45	3.60	3.64	3.66
3.64	3.61	3.61	3.64	3.69	3.75	3.88	4.03	4.21	4.34
4.47	4.64	4.83	5.00	5.11	5.21	5.35	5.49	5.63	5.73
5.83	5.93	6.05	6.17	6.28	6 36	6.44	6.54	6.64	6.72
6.79	6.85	6.95	7.05	7.05	7.05	7.22	7.29	7.38	7.46
7.53	7.58	7.64	7.72	7.80	7.87	7.92	7.97	8.04	8.12
8.19	8.25	8.31	8.38	8.45					
-6.06	-4.70	-3.43	-2.46	-1.29	0.38	2.02	2.19	1.99	1.67
1.23	1.38	1.78	2.15	2.56	3.07	3.45	3.59	3.63	3.65
3.63	3.60	3.59	3.63	3.68	3.74	3.87	4.00	4.19	4.33
4.45	4.63	4.82	4.98	5.09	5.20	5.33	5.48	5.62	5.71
5.82	5.91	6.03	6.15	6.26	6.34	6.43	6.54	6.63	6.71
6.77	6.83	6.93	7.04	7.05	7.05	7.22	7.29	7.38	7.46
7.53	7.58	7.64	7.72	7.80	7.87	7.92	7.98	8.04	8.12
8.20	8.25	8.30	8.38	8.46					
-5.98	-4.46	-3.56	-2.44	-1.35	0.33	1.89	2.10	1.89	1.62
1.26	1.40	1.79	2.17	2.56	3.06	3.42	3.58	3.62	3.64
3.62	3.60	3.59	3.61	3.66	3.71	3.83	3.98	4.15	4.29
4.41	4.58	4.77	4.94	5.06	5.16	5.31	5.45	5.59	5.69
5.79	5.89	6.01	6.13	6.24	6.33	6.41	6.52	6.62	6.70
6.75	6.81	6.90	7.01	7.04	7.04	7.22	7.29	7.38	7.46
7.54	7.59	7.64	7.72	7.80	7.87	7.93	7.98	8.04	8.12
8.19	8.25	8.30	8.37	8.44					
-6.09	-4.36	-3.53	-2.41	-1.39	0.27	1.87	2.07	1.85	1.58
1.24	1.40	1.80	2.19	2.57	3.06	3.41	3.57	3.61	3.63
3.62	3.60	3.58	3.60	3.63	3.68	3.79	3.93	4.11	4.24
4.36	4.53	4.73	4.90	5.02	5.13	5.27	5.42	5.56	5.66
5.77	5.86	5.98	6.11	6.23	6.31	6.39	6.50	6.60	6.69
6.74	6.79	6.83	6.99	7.04	7.04	7.22	7.29	7.38	7.46
7.54	7.59	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
8.19	8.25	8.29	8.36	8.43					
-6.34	-4.34	-3.46	-2.39	-1.43	0.18	1.89	2.04	1.81	1.53
1.21	1.40	1.81	2.21	2.58	3.05	3.41	3.56	3.60	3.62
3.62	3.60	3.58	3.58	3.61	3.64	3.75	3.88	4.05	4.18

4.30	4.47	4.67	4.85	4.97	5.09	5.24	5.39	5.53	5.63
5.74	5.83	5.96	6.09	6.21	6.29	6.37	6.48	6.59	6.68
6.73	6.78	6.80	6.98	7.08	7.15	7.23	7.29	7.38	7.47
7.54	7.59	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
9.19	8.24	8.29	8.34	8.42					
-6.40	-4.42	-3.48	-2.41	-1.48	0.10	1.80	2.01	1.78	1.49
1.22	1.41	1.82	2.21	2.58	3.04	3.39	3.55	3.59	3.61
3.61	3.60	3.57	3.57	3.58	3.61	3.70	3.82	3.99	4.12
4.24	4.41	4.61	4.79	4.92	5.04	5.20	5.36	5.50	5.60
5.71	5.81	5.93	6.07	6.19	6.27	6.35	6.46	6.57	6.67
6.73	6.78	6.79	6.98	7.08	7.15	7.23	7.30	7.38	7.47
7.54	7.60	7.65	7.72	7.80	7.88	7.93	7.98	8.04	8.12
8.19	8.24	8.28	8.33	8.40					
-6.36	-4.52	-3.50	-2.43	-1.52	0.04	1.68	1.98	1.74	1.46
1.24	1.43	1.83	2.22	2.59	3.03	3.37	3.54	3.57	3.60
3.61	3.60	3.56	3.55	3.56	3.58	3.66	3.78	3.93	4.06
4.18	4.36	4.56	4.74	4.88	5.00	5.17	5.33	5.47	5.57
5.68	5.78	5.91	6.04	6.17	6.25	6.33	6.44	6.55	6.66
6.72	6.77	6.79	6.98	7.08	7.15	7.23	7.30	7.38	7.47
7.55	7.60	7.65	7.73	7.80	7.88	7.93	7.98	8.04	8.12
8.18	8.24	8.28	8.32	8.39					
-6.51	-4.60	-3.59	-2.47	-1.57	-0.03	1.66	1.94	1.71	1.42
1.23	1.43	1.84	2.23	2.59	3.02	3.36	3.53	3.56	3.59
3.60	3.60	3.56	3.54	3.54	3.55	3.62	3.73	3.88	4.01
4.13	4.31	4.51	4.70	4.84	4.97	5.14	5.30	5.44	5.55
5.66	5.76	5.89	6.03	6.15	6.23	6.31	6.42	6.54	6.65
6.71	6.76	6.78	6.97	7.08	7.15	7.23	7.30	7.38	7.47
7.55	7.60	7.65	7.73	7.81	7.88	7.93	7.98	8.04	8.12
8.18	8.24	8.27	8.31	8.38					
-6.75	-4.84	-3.55	-2.48	-1.62	-0.14	1.66	1.91	1.66	1.39
1.21	1.44	1.86	2.25	2.60	3.02	3.35	3.53	3.56	3.59
3.60	3.61	3.55	3.52	3.52	3.51	3.58	3.68	3.82	3.95
4.07	4.25	4.46	4.65	4.79	4.92	5.10	5.27	5.41	5.52
5.63	5.73	5.86	6.01	6.13	6.21	6.30	6.40	6.53	6.64
6.70	6.76	6.78	6.98	7.08	7.16	7.24	7.30	7.38	7.47
7.55	7.60	7.66	7.73	7.81	7.89	7.93	7.98	8.04	8.12
8.18	8.23	8.27	8.29	8.37					
-6.54	-5.40	-3.38	-2.43	-1.59	-0.08	1.63	1.90	1.65	1.39
1.23	1.47	1.92	2.31	2.66	3.06	3.38	3.54	3.57	3.60
3.62	3.62	3.56	3.52	3.51	3.50	3.55	3.64	3.78	3.90
4.02	4.20	4.40	4.60	4.75	4.89	5.07	5.23	5.38	5.49
5.61	5.71	5.84	5.99	6.12	6.21	6.29	6.40	6.53	6.64
6.70	6.75	6.77	6.99	7.10	7.17	7.25	7.31	7.39	7.48
7.56	7.61	7.66	7.73	7.81	7.89	7.93	7.98	8.04	8.11
8.18	8.23	8.26	8.28	8.35					
-6.21	-4.23	-3.03	-2.27	-1.50	0.08	1.68	1.91	1.69	1.43
1.26	1.52	2.01	2.41	2.77	3.15	3.44	3.58	3.61	3.64
3.65	3.63	3.58	3.54	3.52	3.51	3.55	3.62	3.74	3.85
3.97	4.15	4.35	4.56	4.72	4.86	5.03	5.20	5.36	5.47
5.59	5.69	5.84	5.99	6.12	6.21	6.30	6.42	6.54	6.66
6.71	6.75	6.76	7.02	7.12	7.20	7.27	7.33	7.41	7.49
7.57	7.62	7.67	7.74	7.81	7.89	7.93	7.98	8.04	8.11
8.17	8.22	8.25	8.27	8.34					
-4.50	-2.95	-2.74	-2.16	-1.38	0.24	1.71	1.93	1.72	1.47
1.29	1.57	2.10	2.51	2.87	3.24	3.50	3.62	3.65	3.68
3.69	3.65	3.59	3.56	3.54	3.53	3.54	3.60	3.71	3.82
3.93	4.10	4.31	4.53	4.69	4.83	5.01	5.18	5.33	5.45
5.57	5.68	5.84	5.99	6.13	6.22	6.32	6.43	6.56	6.68
6.71	6.74	6.75	7.05	7.15	7.22	7.29	7.35	7.42	7.50
7.58	7.63	7.68	7.74	7.81	7.88	7.93	7.98	8.04	8.10

8.17	8.21	8.24	8.27	8.33					
-4.50	-3.07	-2.80	-2.18	-1.31	0.41	1.75	1.95	1.73	1.49
1.31	1.59	2.18	2.61	2.98	3.33	3.56	3.67	3.70	3.72
3.72	3.67	3.61	3.57	3.56	3.54	3.54	3.58	3.68	3.79
3.89	4.07	4.28	4.50	4.67	4.82	4.99	5.16	5.32	5.45
5.57	5.69	5.84	6.00	6.15	6.25	6.34	6.46	6.58	6.70
6.73	6.74	6.75	7.08	7.18	7.24	7.31	7.37	7.44	7.51
7.59	7.64	7.69	7.75	7.82	7.89	7.93	7.98	8.04	8.10
8.17	8.20	8.22	8.25	8.32					
-6.24	-5.02	-3.52	-2.48	-1.47	0.29	1.68	1.84	1.65	1.42
1.27	1.63	2.24	2.69	3.06	3.40	3.62	3.71	3.73	3.75
3.75	3.69	3.62	3.59	3.57	3.55	3.56	3.60	3.70	3.80
3.91	4.09	4.31	4.54	4.71	4.86	5.04	5.22	5.38	5.50
5.63	5.75	5.91	6.06	6.20	6.30	6.39	6.51	6.63	6.74
6.76	6.77	6.78	7.11	7.20	7.27	7.34	7.39	7.46	7.53
7.60	7.65	7.69	7.75	7.82	7.88	7.93	7.98	8.04	8.09
8.17	8.19	8.21	8.24	8.31					
-6.43	-5.68	-3.79	-2.77	-1.68	0.07	1.54	1.71	1.53	1.31
1.21	1.65	2.30	2.74	3.11	3.46	3.67	3.75	3.76	3.77
3.77	3.70	3.63	3.60	3.58	3.57	3.59	3.63	3.74	3.84
3.96	4.15	4.38	4.61	4.78	4.94	5.14	5.33	5.49	5.60
5.72	5.84	6.00	6.15	6.28	6.37	6.46	6.58	6.70	6.80
6.81	6.82	6.82	7.14	7.23	7.30	7.36	7.42	7.48	7.54
7.61	7.65	7.70	7.76	7.82	7.89	7.93	7.98	8.04	8.09
8.16	8.19	8.21	8.24	8.30					
-6.30	-5.15	-4.04	-2.72	-1.59	0.16	1.53	1.67	1.48	1.26
1.23	1.71	2.37	2.80	3.18	3.53	3.73	3.79	3.79	3.79
3.80	3.72	3.64	3.61	3.60	3.59	3.62	3.67	3.78	3.90
4.02	4.21	4.45	4.69	4.87	5.03	5.24	5.43	5.59	5.71
5.83	5.94	6.10	6.24	6.37	6.45	6.54	6.65	6.76	6.86
6.87	6.88	6.88	7.19	7.26	7.32	7.38	7.44	7.50	7.56
7.62	7.66	7.71	7.77	7.83	7.89	7.93	7.98	8.04	8.09
8.17	8.20	8.22	8.26	8.32					
-6.27	-4.96	-3.87	-2.54	-1.36	0.32	1.61	1.69	1.46	1.23
1.26	1.78	2.45	2.88	3.26	3.61	3.79	3.84	3.83	3.82
3.82	3.73	3.65	3.62	3.61	3.61	3.64	3.71	3.82	3.95
4.07	4.27	4.52	4.77	4.95	5.12	5.34	5.53	5.70	5.82
5.94	6.05	6.19	6.33	6.45	6.53	6.62	6.72	6.83	6.91
6.93	6.94	6.94	7.23	7.30	7.35	7.41	7.45	7.52	7.58
7.63	7.67	7.71	7.77	7.83	7.89	7.94	7.98	8.04	8.10
8.18	8.22	8.25	8.29	8.34					
-6.32	-4.88	-3.59	-2.33	-1.13	0.48	1.71	1.72	1.45	1.22
1.27	1.85	2.53	2.94	3.33	3.68	3.85	3.89	3.87	3.87
3.86	3.75	3.67	3.65	3.65	3.64	3.68	3.76	3.88	4.01
4.14	4.34	4.59	4.85	5.05	5.23	5.45	5.63	5.82	5.94
6.06	6.16	6.29	6.43	6.55	6.63	6.70	6.79	6.89	6.98
6.99	7.00	7.00	7.27	7.33	7.38	7.43	7.47	7.54	7.59
7.64	7.67	7.71	7.78	7.84	7.90	7.94	7.98	8.04	8.11
8.19	8.23	8.27	8.31	8.36					
-6.40	-5.21	-3.31	-2.21	-0.96	0.62	1.89	1.74	1.36	1.21
1.28	1.91	2.62	3.01	3.43	3.78	3.93	4.00	4.00	3.98
3.97	3.80	3.77	3.83	3.84	3.80	3.76	3.85	4.04	4.21
4.33	4.47	4.70	5.05	5.29	5.47	5.65	5.77	6.04	6.22
6.35	6.40	6.43	6.60	6.78	6.86	6.89	6.90	6.98	7.09
7.11	7.11	7.13	7.31	7.36	7.40	7.44	7.49	7.56	7.61
7.64	7.67	7.71	7.78	7.84	7.90	7.94	7.98	8.04	8.11
8.20	8.24	8.29	8.34	8.38					
-6.29	-4.73	-3.44	-2.16	-1.01	0.42	1.71	1.74	1.50	1.28
1.37	1.87	2.65	3.15	3.62	4.00	4.23	4.30	4.33	4.36
4.38	4.40	4.38	4.39	4.36	4.32	4.36	4.40	4.48	4.64

4.81	5.05	5.33	5.58	5.79	5.99	6.26	6.52	6.71	6.82
6.95	7.05	7.21	7.28	7.33	7.32	7.32	7.31	7.31	7.35
7.34	7.34	7.34	7.34	7.38	7.41	7.44	7.48	7.54	7.59
7.63	7.66	7.70	7.76	7.83	7.89	7.93	7.97	8.03	8.10
8.19	8.24	8.29	8.34	8.38					
-6.10	-4.78	-3.46	-2.13	-1.07	0.28	1.55	1.70	1.52	1.34
1.45	1.89	2.72	3.29	3.81	4.20	4.48	4.59	4.68	4.76
4.82	4.93	4.97	4.96	4.88	4.80	4.82	4.82	4.86	5.03
5.23	5.53	5.81	6.04	6.25	6.47	6.78	7.08	7.26	7.36
7.49	7.63	7.79	7.82	7.81	7.75	7.69	7.63	7.57	7.57
7.55	7.55	7.53	7.36	7.39	7.41	7.44	7.47	7.52	7.57
7.61	7.64	7.68	7.75	7.82	7.88	7.92	7.97	8.03	8.09
8.17	8.24	8.29	8.34	8.38					
-6.12	-4.90	-3.48	-2.15	-1.17	0.12	1.46	1.52	1.40	1.32
1.46	1.87	2.82	3.39	3.93	4.35	4.68	4.86	5.01	5.13
5.20	5.36	5.44	5.40	5.31	5.17	5.15	5.11	5.19	5.40
5.59	5.86	6.19	6.43	6.70	6.92	7.17	7.54	7.68	7.85
8.00	8.08	8.27	8.23	8.22	8.12	7.97	7.85	7.75	7.73
7.72	7.70	7.72	7.38	7.39	7.41	7.44	7.46	7.51	7.55
7.59	7.63	7.66	7.73	7.81	7.87	7.91	7.96	8.02	8.08
8.17	8.23	8.29	8.35	8.39					
-5.91	-5.18	-3.16	-2.15	-1.34	-0.20	1.03	1.22	1.20	1.25
1.55	1.79	2.68	3.48	3.99	4.52	4.99	5.10	5.27	5.38
5.50	5.95	5.84	5.69	5.58	5.54	5.82	5.70	5.59	5.78
6.00	6.47	6.93	6.95	7.18	7.40	7.80	8.46	8.33	8.32
8.48	8.67	9.19	8.93	8.73	8.53	8.28	8.30	8.11	7.97
7.92	7.94	7.85	7.41	7.41	7.41	7.43	7.44	7.49	7.54
7.58	7.61	7.66	7.72	7.79	7.85	7.90	7.94	8.00	8.07
8.16	8.22	8.27	8.33	8.37					
-6.27	-4.93	-3.40	-2.21	-1.51	-0.89	0.22	0.79	0.97	1.10
1.45	1.95	2.41	3.05	3.57	4.07	4.43	4.85	5.04	5.16
5.20	5.18	5.13	5.09	5.02	4.85	4.58	4.68	5.04	5.31
5.49	5.61	5.86	6.42	6.74	6.94	7.07	7.12	7.42	7.64
7.80	7.84	7.86	7.91	8.00	7.92	7.76	7.69	7.63	7.79
7.84	7.87	7.88	7.30	7.34	7.36	7.38	7.39	7.43	7.50
7.55	7.59	7.63	7.69	7.77	7.83	7.88	7.93	7.99	8.06
8.14	8.21	8.27	8.33	8.37					
-6.46	-5.08	-3.58	-2.32	-1.45	-0.46	0.70	0.90	1.04	1.19
1.46	1.69	2.11	2.62	3.07	3.55	3.93	4.42	4.63	4.72
4.66	4.45	4.43	4.42	4.35	4.20	4.03	4.19	4.53	4.78
4.97	5.14	5.40	5.88	6.15	6.33	6.44	6.50	6.76	6.94
7.07	7.11	7.19	7.31	7.41	7.42	7.39	7.36	7.35	7.62
7.71	7.77	7.79	7.22	7.27	7.31	7.33	7.35	7.39	7.46
7.52	7.56	7.61	7.67	7.75	7.82	7.87	7.92	7.98	8.05
8.13	8.20	8.26	8.33	8.37					
-6.57	-5.42	-3.59	-2.39	-1.25	-0.08	1.14	1.20	1.29	1.42
1.52	1.52	1.76	2.12	2.48	3.00	3.46	3.87	4.05	4.09
3.99	3.82	3.68	3.60	3.57	3.50	3.53	3.72	3.97	4.18
4.36	4.63	4.93	5.22	5.42	5.58	5.77	5.96	6.10	6.19
6.30	6.39	6.63	6.78	6.86	6.93	6.99	7.07	7.11	7.40
7.52	7.62	7.66	7.12	7.20	7.24	7.27	7.29	7.34	7.41
7.48	7.53	7.58	7.65	7.73	7.80	7.85	7.90	7.97	8.04
8.12	8.19	8.26	8.32	8.35					
-6.72	-5.30	-3.67	-2.32	-1.08	0.26	1.44	1.50	1.61	1.76
1.80	1.56	1.68	1.96	2.26	2.79	3.28	3.63	3.75	3.78
3.69	3.53	3.42	3.35	3.34	3.31	3.35	3.56	3.79	3.97
4.14	4.39	4.66	4.91	5.09	5.24	5.42	5.61	5.75	5.85
5.96	6.04	6.26	6.42	6.53	6.62	6.70	6.81	6.87	7.24
7.39	7.52	7.55	7.05	7.13	7.18	7.22	7.26	7.32	7.40
7.47	7.51	7.56	7.64	7.72	7.79	7.84	7.90	7.97	8.04

8.12	8.19	8.25	8.32	8.36					
-6.66	-5.30	-3.51	-2.25	-0.88	0.58	1.56	1.76	1.93	2.12
2.22	1.84	1.76	1.98	2.26	2.81	3.30	3.55	3.63	3.65
3.62	3.57	3.50	3.42	3.39	3.38	3.46	3.62	3.79	3.94
4.09	4.30	4.55	4.78	4.95	5.09	5.27	5.44	5.58	5.68
5.79	5.88	6.02	6.15	6.29	6.39	6.47	6.58	6.66	7.11
7.30	7.44	7.50	7.01	7.09	7.14	7.20	7.25	7.33	7.41
7.47	7.52	7.57	7.64	7.72	7.79	7.84	7.90	7.98	8.06
8.13	8.19	8.25	8.32	8.37					
-6.68	-5.03	-3.55	-2.09	-0.81	0.75	1.63	1.93	2.11	2.28
2.26	1.81	1.82	2.07	2.37	2.92	3.38	3.59	3.64	3.68
3.68	3.65	3.59	3.52	3.50	3.48	3.53	3.67	3.82	3.96
4.09	4.28	4.50	4.72	4.87	5.01	5.18	5.35	5.49	5.60
5.71	5.80	5.93	6.05	6.17	6.27	6.36	6.48	6.58	7.06
7.27	7.44	7.49	6.99	7.06	7.12	7.18	7.24	7.32	7.40
7.46	7.51	7.56	7.64	7.71	7.78	7.84	7.90	7.98	8.06
8.13	8.18	8.23	8.31	8.36					
-6.77	-4.75	-3.43	-1.93	-0.75	0.88	1.76	2.06	2.20	2.31
2.61	1.71	1.84	2.18	2.52	3.06	3.47	3.68	3.73	3.76
3.77	3.74	3.68	3.62	3.59	3.56	3.59	3.71	3.85	3.98
4.10	4.27	4.48	4.67	4.82	4.95	5.12	5.29	5.43	5.54
5.65	5.76	5.88	6.00	6.12	6.22	6.32	6.45	7.54	7.06
7.28	7.47	7.53	6.96	7.05	7.10	7.17	7.23	7.31	7.39
7.45	7.50	7.55	7.63	7.70	7.78	7.83	7.89	7.97	8.05
8.12	8.16	8.20	8.28	8.33					
-6.94	-4.54	-3.32	-1.79	-0.67	1.01	1.89	2.17	2.26	2.32
2.04	1.59	1.86	2.27	2.67	3.20	3.58	3.78	3.83	3.86
3.86	3.83	3.77	3.70	3.66	3.63	3.65	3.75	3.88	4.00
4.11	4.27	4.45	4.63	4.77	4.90	5.06	5.23	5.38	5.49
5.61	5.72	5.85	5.97	6.09	6.19	6.29	6.41	6.49	7.08
7.32	7.52	7.57	6.93	7.03	7.09	7.16	7.22	7.30	7.38
7.44	7.49	7.55	7.62	7.69	7.77	7.83	7.89	7.96	8.04
8.11	8.14	8.18	8.25	8.30					
-7.12	-4.54	-3.27	-1.72	-0.57	1.13	2.01	2.25	2.29	2.29
1.91	1.44	1.88	2.36	2.82	3.32	3.68	3.86	3.91	3.93
3.95	3.93	3.85	3.77	3.73	3.70	3.70	3.79	3.91	4.02
4.13	4.27	4.42	4.61	4.75	4.87	5.02	5.17	5.33	5.45
5.58	5.69	5.81	5.94	6.07	6.17	6.26	6.38	6.44	7.09
7.34	7.56	7.62	6.91	7.01	7.07	7.14	7.20	7.28	7.36
7.43	7.48	7.54	7.61	7.68	7.76	7.82	7.88	7.95	8.03
8.10	8.12	8.16	8.23	8.27					
-6.98	-4.16	-3.15	-1.69	-0.62	1.16	2.02	2.27	2.24	2.15
1.71	1.48	1.93	2.40	2.83	3.34	3.68	3.86	3.91	3.95
3.96	3.93	3.87	3.80	3.77	3.74	3.74	3.83	3.95	4.05
4.15	4.29	4.46	4.63	4.76	4.88	5.03	5.19	5.33	5.45
5.57	5.68	5.80	5.94	6.06	6.16	6.25	6.36	6.41	7.10
7.38	7.61	7.67	6.89	7.00	7.06	7.13	7.19	7.28	7.36
7.43	7.48	7.54	7.61	7.68	7.76	7.82	7.88	7.95	8.03
8.10	8.13	8.17	8.24	8.27					
-6.72	-3.93	-2.91	-1.71	-0.65	1.15	2.02	2.25	2.15	1.98
1.51	1.51	1.99	2.43	2.84	3.34	3.68	3.91	3.94	3.96
3.93	3.88	3.83	3.79	3.77	3.77	3.77	3.87	3.98	4.08
4.18	4.32	4.49	4.66	4.79	4.91	5.06	5.21	5.34	5.45
5.56	5.67	5.80	5.94	6.06	6.15	6.24	6.35	6.40	7.12
7.41	7.66	7.73	6.88	6.98	7.05	7.12	7.18	7.27	7.35
7.42	7.48	7.54	7.61	7.68	7.75	7.81	7.87	7.94	8.02
8.09	8.14	8.18	8.25	8.27					
-6.41	-3.91	-2.91	-1.74	-0.65	1.14	1.99	2.23	2.07	1.83
1.35	1.52	2.03	2.46	2.86	3.34	3.67	3.85	3.90	3.94
3.95	3.93	3.89	3.84	3.81	3.79	3.81	3.91	4.01	4.10

4.20	4.35	4.52	4.69	4.82	4.93	5.08	5.22	5.35	5.46
5.56	5.66	5.80	5.94	6.06	6.15	6.23	6.33	6.40	7.14
7.45	7.72	7.80	6.86	6.96	7.03	7.11	7.18	7.26	7.34
7.42	7.48	7.54	7.62	7.69	7.75	7.81	7.86	7.94	8.01
8.09	8.14	8.19	8.25	8.27					
-6.12	-4.03	-2.90	-1.80	-0.67	1.09	1.95	2.21	2.00	1.72
1.27	1.52	2.03	2.46	2.86	3.33	3.65	3.83	3.88	3.92
3.93	3.92	3.89	3.84	3.82	3.80	3.83	3.92	4.03	4.12
4.22	4.37	4.54	4.71	4.84	4.95	5.09	5.23	6.36	5.46
5.57	5.66	5.80	5.94	6.07	6.15	6.23	6.32	6.42	7.18
7.52	7.81	7.91	6.85	6.96	7.02	7.10	7.17	7.26	7.34
7.42	7.47	7.54	7.61	7.68	7.75	7.80	7.86	7.93	8.00
8.09	8.14	8.20	8.26	8.27					
-6.26	-4.10	-3.02	-1.84	-0.77	0.98	1.96	2.19	1.96	1.66
1.24	1.49	1.99	2.43	2.83	3.30	3.62	3.80	3.85	3.89
3.90	3.89	3.86	3.82	3.81	3.80	3.82	3.93	4.03	4.13
4.23	4.37	4.55	4.72	4.85	4.96	5.10	5.24	5.37	5.47
5.57	5.67	5.80	5.95	6.07	6.15	6.23	6.34	6.42	7.27
7.64	7.96	8.04	6.85	6.95	7.02	7.10	7.16	7.25	7.33
7.41	7.47	7.53	7.61	7.68	7.74	7.80	7.85	7.92	8.00
8.08	8.14	8.19	8.25	8.27					
-6.37	-4.30	-3.13	-1.91	-0.90	0.87	1.97	2.17	1.92	1.62
1.22	1.46	1.93	2.38	2.79	3.27	3.59	3.76	3.81	3.85
3.87	3.85	3.82	3.80	3.79	3.79	3.81	3.93	4.04	4.13
4.23	4.38	4.56	4.73	4.85	4.96	5.10	5.25	5.38	5.47
5.58	5.67	5.81	5.95	6.07	6.15	6.24	6.36	6.42	7.39
7.78	8.13	8.22	6.85	6.95	7.02	7.09	7.16	7.24	7.33
7.41	7.46	7.52	7.60	7.67	7.74	7.79	7.84	7.91	7.99
8.07	8.13	8.18	8.24	8.27					
-6.22	-4.52	-3.26	-2.02	-0.98	0.70	1.91	2.13	1.88	1.58
1.26	1.44	1.87	2.32	2.75	3.24	3.55	3.72	3.77	3.81
3.83	3.81	3.79	3.77	3.77	3.77	3.81	3.92	4.04	4.14
4.24	4.39	4.57	4.73	4.86	4.96	5.10	5.25	5.38	5.48
5.58	5.68	5.81	5.96	6.07	6.16	6.25	6.38	6.49	7.49
7.92	8.30	8.41	6.85	6.94	7.01	7.09	7.15	7.24	7.33
7.40	7.46	7.52	7.59	7.66	7.73	7.79	7.84	7.91	7.98
8.06	8.12	8.17	8.23	8.27					
-6.10	-4.71	-3.38	-2.12	-1.06	0.58	1.86	2.10	1.85	1.54
1.28	1.42	1.80	2.27	2.71	3.21	3.51	3.68	3.73	3.77
3.79	3.77	3.76	3.74	3.75	3.76	3.81	3.92	4.04	4.14
4.24	4.39	4.57	4.74	4.86	4.97	5.10	5.25	5.39	5.49
5.59	5.69	5.82	5.96	6.07	6.16	6.25	6.40	6.55	7.58
8.07	8.46	8.57	6.84	6.94	7.01	7.08	7.15	7.23	7.32
7.40	7.45	7.51	7.58	7.65	7.73	7.78	7.83	7.90	7.98
8.06	8.11	8.16	8.22	8.26					
-6.13	-4.88	-3.50	-2.22	-1.16	0.47	1.87	2.06	1.81	1.51
1.28	1.39	1.75	2.22	2.67	3.18	3.48	3.64	3.70	3.74
3.76	3.74	3.72	3.71	3.73	3.75	3.80	3.92	4.04	4.14
4.24	4.39	4.58	4.74	4.86	4.97	5.10	5.26	5.39	5.49
5.60	5.69	5.82	5.96	6.07	6.16	6.26	6.42	6.55	7.68
8.19	8.62	8.74	6.84	6.94	7.01	7.08	7.15	7.23	7.32
7.39	7.45	7.50	7.57	7.65	7.72	7.77	7.82	7.89	7.97
8.05	8.10	8.15	8.21	8.26					
-6.12	-5.00	-3.62	-2.41	-1.32	0.32	1.87	2.02	1.77	1.48
1.29	1.35	1.68	2.16	2.63	3.15	3.45	3.60	3.66	3.70
3.72	3.70	3.69	3.68	3.71	3.74	3.79	3.92	4.04	4.15
4.25	4.40	4.59	4.75	4.87	4.97	5.10	5.27	5.40	5.50
5.61	5.70	5.83	5.97	6.07	6.17	6.27	6.44	6.54	7.80
8.33	8.80	8.93	6.84	6.94	7.00	7.08	7.14	7.22	7.32
7.39	7.44	7.49	7.56	7.64	7.72	7.77	7.82	7.88	7.96

8.04	8.10	8.14	8.20	8.27					
-5.96	-5.15	-3.49	-2.55	-1.40	0.12	1.77	2.03	1.71	1.45
1.31	1.32	1.62	2.11	2.60	3.13	3.39	3.56	3.63	3.67
3.68	3.66	3.66	3.66	3.69	3.73	3.79	3.91	4.04	4.15
4.26	4.40	4.59	4.75	4.87	4.97	5.10	5.27	5.40	5.50
5.61	5.71	5.83	5.97	6.08	6.18	6.28	6.46	6.64	7.91
8.49	8.98	9.13	6.84	6.93	7.00	7.07	7.14	7.21	7.31
7.39	7.44	7.49	7.55	7.63	7.71	7.76	7.81	7.88	7.96
8.03	8.09	8.13	8.19	8.26					
-5.96	-5.08	-3.71	-2.55	-1.48	0.04	1.66	1.98	1.76	1.50
1.36	1.35	1.60	2.08	2.55	3.10	3.40	3.56	3.62	3.66
3.68	3.66	3.66	3.66	3.69	3.73	3.80	3.92	4.04	4.15
4.25	4.40	4.58	4.75	4.86	4.97	5.10	5.27	5.41	5.51
5.62	5.71	5.84	5.99	6.10	6.21	6.32	6.51	6.74	8.03
8.64	9.17	9.32	6.84	6.93	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.54	7.62	7.70	7.75	7.80	7.87	7.95
8.03	8.08	8.13	8.19	8.25					
-5.98	-5.06	-3.75	-2.58	-1.56	-0.08	1.56	1.96	1.79	1.57
1.40	1.37	1.59	2.05	2.51	3.07	3.40	3.57	3.62	3.66
3.67	3.66	3.66	3.68	3.70	3.74	3.81	3.92	4.04	4.14
4.25	4.40	4.58	4.74	4.86	4.97	5.11	5.27	5.41	5.51
5.62	5.72	5.86	6.01	6.13	6.25	6.37	6.58	6.82	8.18
8.83	9.38	9.54	6.84	6.94	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.54	7.62	7.69	7.75	7.80	7.87	7.95
8.02	8.07	8.12	8.18	8.24					
-6.04	-5.02	-3.73	-2.60	-1.64	-0.20	1.50	1.95	1.83	1.63
1.45	1.39	1.58	2.02	2.47	3.06	3.40	3.58	3.63	3.66
3.67	3.67	3.67	3.69	3.71	3.74	3.82	3.92	4.04	4.14
4.24	4.39	4.57	4.73	4.85	4.96	5.11	5.27	5.42	5.52
5.63	5.72	5.87	6.03	6.16	6.28	6.41	6.64	6.86	8.33
9.02	9.59	9.71	6.85	6.94	7.00	7.07	7.13	7.21	7.31
7.39	7.44	7.48	7.53	7.61	7.69	7.74	7.79	7.87	7.95
8.01	8.06	8.11	8.17	8.24					
-6.10	-4.82	-3.46	-2.63	-1.77	-0.36	1.36	1.93	1.83	1.69
1.49	1.40	1.56	2.01	2.43	3.04	3.41	3.59	3.64	3.67
3.67	3.67	3.68	3.70	3.72	3.75	3.83	3.93	4.05	4.14
4.24	4.39	4.56	4.73	4.85	4.96	5.11	5.27	5.42	5.52
5.63	5.73	5.88	6.05	6.18	6.30	6.44	6.70	6.89	8.47
9.14	9.75	9.83	6.85	6.94	7.00	7.07	7.12	7.20	7.31
7.39	7.44	7.48	7.53	7.60	7.68	7.74	7.79	7.86	7.94
8.01	8.06	8.10	8.16	8.23					

(iii) LOC.DAT

```
1
56. 944. 12.
1
-88. 1088. 24.
```

Appendix D

Input/Output Data Files for Wave Propagating Over Currents

(i) IN.DAT
(ii) DEPTH.DAT
(iii) CURRNX.DAT
(iv) CURRNY.DAT
(v) LOC.DAT
(vi) OUT01.DAT

(i) IN.DAT

```
           2
           0           0
    1.000000    8.000000      0.00000     32.20000    0.0000000E+00
          61          61
    1000.000   -400.0000    10.000000    10.000000              81
         100 2.000001E-02 2.0000000E-02  990.0000   0.0000000E+00
           1
           1
           2
           0           0
           0 1.0000000E+03 1.000000E-02
           1
           1
           0
 CURRENT-WAVE INTERACTION
          10
    0.000000   0.0000000     1000.000     0.000000
    0.000000   350.00000     1000.000     350.0000
    0.000000   50.000000     1000.000     50.00000
    0.000000   100.00000     1000.000     100.0000
    0.000000   150.00000     1000.000     150.0000
    550.0000   -200.0000     550.0000     200.0000
    450.0000   -200.0000     450.0000     200.0000
    350.0000   -200.0000     350.0000     200.0000
    250.0000   -200.0000     250.0000     200.0000
    150.0000   -200.0000     150.0000     200.0000
```

(ii) DEPTH.DAT

```
0
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.3000  0.3000  0.3000  0.3000  0.3000  0.3000  0.3000
0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
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0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
0.6000  0.6000  0.6000  0.6000  0.6000  0.6000  0.6000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
0.9000  0.9000  0.9000  0.9000  0.9000  0.9000  0.9000
1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000
1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000
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1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000
1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000
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1.2000  1.2000  1.2000  1.2000  1.2000  1.2000  1.2000
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1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
1.5000  1.5000  1.5000  1.5000  1.5000  1.5000  1.5000
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1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000
1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000  1.8000
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2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000
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2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000
2.1000  2.1000  2.1000  2.1000  2.1000  2.1000  2.1000
2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000
2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000
2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000  2.4000
```

2.4000	2.4000	2.4000	2.4000	2.4000	2.4000	2.4000	2.4000	2.4000
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2.4000	2.4000	2.4000	2.4000	2.4000	2.4000	2.4000		
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2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000
2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000
2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000
2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000
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2.7000	2.7000	2.7000	2.7000	2.7000	2.7000	2.7000		
3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000
3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000
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3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000		
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3.3000	3.3000	3.3000	3.3000	3.3000	3.3000	3.3000	3.3000	3.3000
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3.3000	3.3000	3.3000	3.3000	3.3000	3.3000	3.3000		
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3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000
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3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000		
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3.9000	3.9000	3.9000	3.9000	3.9000	3.9000	3.9000	3.9000	3.9000
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4.2000	4.2000	4.2000	4.2000	4.2000	4.2000	4.2000		
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4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000
4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000
4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000	4.5000
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5.1000	5.1000	5.1000	5.1000	5.1000	5.1000	5.1000		
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5.4000	5.4000	5.4000	5.4000	5.4000	5.4000	5.4000		
5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000
5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000
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5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000
5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000
5.7000	5.7000	5.7000	5.7000	5.7000	5.7000	5.7000		
6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
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6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000		
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6.3000	6.3000	6.3000	6.3000	6.3000	6.3000	6.3000		
6.6000	6.6000	6.6000	6.6000	6.6000	6.6000	6.6000	6.6000	6.6000
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17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000
17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000
17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000
17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000
17.5000	17.5000	17.5000	17.5000	17.5000	17.5000	17.5000		
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000
18.0000	18.0000	18.0000	18.0000	18.0000	18.0000	18.0000		
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000
18.5000	18.5000	18.5000	18.5000	18.5000	18.5000	18.5000		
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000
19.0000	19.0000	19.0000	19.0000	19.0000	19.0000	19.0000		
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000
19.5000	19.5000	19.5000	19.5000	19.5000	19.5000	19.5000		
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000
20.0000	20.0000	20.0000	20.0000	20.0000	20.0000	20.0000		
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000
20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000

20.5000	20.5000	20.5000	20.5000	20.5000	20.5000	20.5000		
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000
21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000		

(iii) CURRNX.DAT

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0005	0.0021	0.0068	0.0193	0.0464	0.0954
0.1670	0.2492	0.3168	0.3432	0.3168	0.2492	0.1670	0.0954	0.0464
0.0193	0.0068	0.0021	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0002	0.0010	0.0041	0.0135	0.0383	0.0924	0.1898
0.3323	0.4957	0.6301	0.6826	0.6301	0.4957	0.3323	0.1898	0.0924
0.0383	0.0135	0.0041	0.0010	0.0002	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0003	0.0016	0.0061	0.0201	0.0570	0.1373	0.2821
0.4939	0.7369	0.9367	1.0148	0.9367	0.7369	0.4939	0.2821	0.1373
0.0570	0.0201	0.0061	0.0016	0.0003	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0004	0.0020	0.0080	0.0265	0.0750	0.1808	0.3715
0.6503	0.9702	1.2333	1.3361	1.2333	0.9702	0.6503	0.3715	0.1808
0.0750	0.0265	0.0080	0.0020	0.0004	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0006	0.0025	0.0098	0.0326	0.0922	0.2224	0.4569
0.7998	1.1932	1.5169	1.6432	1.5169	1.1932	0.7998	0.4569	0.2224
0.0922	0.0326	0.0098	0.0025	0.0006	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0006	0.0030	0.0116	0.0384	0.1085	0.2616	0.5375
0.9410	1.4038	1.7846	1.9332	1.7846	1.4038	0.9410	0.5375	0.2616
0.1085	0.0384	0.0116	0.0030	0.0006	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0007	0.0034	0.0132	0.0437	0.1237	0.2982	0.6126
1.0724	1.5999	2.0339	2.2033	2.0339	1.5999	1.0724	0.6126	0.2982
0.1237	0.0437	0.0132	0.0034	0.0007	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0008	0.0038	0.0146	0.0486	0.1376	0.3317	0.6815
1.1930	1.7797	2.2625	2.4509	2.2625	1.7797	1.1930	0.6815	0.3317

0.1376	0.0466	0.0146	0.0038	0.0008	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0009	0.0041	0.0160	0.0531	0.1501	0.3619	0.7435
1.3017	1.9419	2.4686	2.6742	2.4686	1.9419	1.3017	0.7435	0.3619
0.1501	0.0531	0.0160	0.0041	0.0009	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0010	0.0044	0.0172	0.0570	0.1612	0.3886	0.7984
1.3977	2.0851	2.6507	2.8714	2.6507	2.0851	1.3977	0.7984	0.3886
0.1612	0.0570	0.0172	0.0044	0.0010	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0010	0.0047	0.0182	0.0603	0.1707	0.4116	0.8456
1.4804	2.2085	2.8076	3.0414	2.8076	2.2085	1.4804	0.8456	0.4116
0.1707	0.0603	0.0182	0.0047	0.0010	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0049	0.0190	0.0632	0.1787	0.4308	0.8851
1.5495	2.3116	2.9386	3.1834	2.9386	2.3116	1.5495	0.8851	0.4308
0.1787	0.0632	0.0190	0.0049	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0051	0.0197	0.0654	0.1851	0.4462	0.9167
1.6048	2.3940	3.0434	3.2969	3.0434	2.3940	1.6048	0.9167	0.4462
0.1851	0.0654	0.0197	0.0051	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0052	0.0202	0.0671	0.1899	0.4577	0.9403
1.6462	2.4559	3.1220	3.3821	3.1220	2.4559	1.6462	0.9403	0.4577
0.1899	0.0671	0.0202	0.0052	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0012	0.0053	0.0206	0.0682	0.1931	0.4655	0.9563
1.6741	2.4975	3.1749	3.4393	3.1749	2.4975	1.6741	0.9563	0.4655
0.1931	0.0682	0.0206	0.0053	0.0012	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0012	0.0053	0.0207	0.0688	0.1948	0.4696	0.9647
1.6886	2.5194	3.2028	3.4695	3.2028	2.5194	1.6886	0.9647	0.4696
0.1948	0.0688	0.0207	0.0053	0.0012	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0012	0.0053	0.0208	0.0689	0.1950	0.4701	0.9658
1.6909	2.5225	3.2067	3.4738	3.2067	2.5225	1.6909	0.9658	0.4701
0.1950	0.0689	0.0208	0.0053	0.0012	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0012	0.0053	0.0206	0.0685	0.1939	0.4674	0.9602
1.6810	2.5078	3.1880	3.4536	3.1880	2.5078	1.6810	0.9602	0.4674
0.1939	0.0685	0.0206	0.0053	0.0012	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0052	0.0204	0.0677	0.1914	0.4616	0.9463
1.6601	2.4766	3.1483	3.4105	3.1483	2.4766	1.6601	0.9463	0.4616
0.1914	0.0677	0.0204	0.0052	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0051	0.0200	0.0664	0.1879	0.4529	0.9305
1.6290	2.4302	3.0894	3.3467	3.0894	2.4302	1.6290	0.9305	0.4529
0.1879	0.0664	0.0200	0.0051	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0050	0.0195	0.0648	0.1832	0.4417	0.9075
1.5888	2.3702	3.0131	3.2640	3.0131	2.3702	1.5888	0.9075	0.4417
0.1832	0.0648	0.0195	0.0050	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0011	0.0049	0.0189	0.0628	0.1777	0.4283	0.8799
1.5404	2.2981	2.9214	3.1647	2.9214	2.2981	1.5404	0.8799	0.4283
0.1777	0.0628	0.0189	0.0049	0.0011	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0010	0.0047	0.0182	0.0605	0.1713	0.4129	0.8483
1.4852	2.2156	2.8166	3.0512	2.8166	2.2156	1.4852	0.8483	0.4129
0.1713	0.0605	0.0182	0.0047	0.0010	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0010	0.0045	0.0175	0.0580	0.1642	0.3959	0.8134
1.4240	2.1244	2.7006	2.9256	2.7006	2.1244	1.4240	0.8134	0.3959
0.1642	0.0580	0.0175	0.0045	0.0010	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0009	0.0043	0.0167	0.0554	0.1566	0.3776	0.7758
1.3581	2.0261	2.5757	2.7902	2.5757	2.0261	1.3581	0.7758	0.3776
0.1566	0.0554	0.0167	0.0043	0.0009	0.0000	0.0000	0.0000	0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0009	0.0041	0.0158	0.0525	0.1486	0.3583	0.7360
1.2886	1.9223	2.4437	2.6473	2.4437	1.9223	1.2886	0.7360	0.3583
0.1486	0.0525	0.0158	0.0041	0.0009	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0008	0.0038	0.0149	0.0496	0.1403	0.3382	0.6948
1.2164	1.8146	2.3068	2.4989	2.3068	1.8146	1.2164	0.6948	0.3382
0.1403	0.0496	0.0149	0.0038	0.0008	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0008	0.0036	0.0140	0.0466	0.1318	0.3177	0.6526
1.1425	1.7044	2.1668	2.3472	2.1668	1.7044	1.1425	0.6526	0.3177
0.1318	0.0466	0.0140	0.0036	0.0008	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0007	0.0034	0.0131	0.0435	0.1232	0.2969	0.6100
1.0679	1.5932	2.0253	2.1940	2.0253	1.5932	1.0679	0.6100	0.2969
0.1232	0.0435	0.0131	0.0034	0.0007	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0007	0.0031	0.0122	0.0405	0.1146	0.2762	0.5675
0.9935	1.4821	1.8841	2.0410	1.8841	1.4821	0.9935	0.5675	0.2762
0.1146	0.0405	0.0122	0.0031	0.0007	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0006	0.0029	0.0113	0.0375	0.1061	0.2557	0.5254
0.9198	1.3722	1.7444	1.8897	1.7444	1.3722	0.9198	0.5254	0.2557
0.1061	0.0375	0.0113	0.0029	0.0006	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0006	0.0027	0.0104	0.0346	0.0978	0.2357	0.4842
0.8477	1.2646	1.6076	1.7415	1.6076	1.2646	0.8477	0.4842	0.2357
0.0978	0.0346	0.0104	0.0027	0.0006	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0005	0.0025	0.0095	0.0317	0.0897	0.2162	0.4442
0.7777	1.1601	1.4748	1.5977	1.4748	1.1601	0.7777	0.4442	0.2162
0.0897	0.0317	0.0095	0.0025	0.0005	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

0.0000	0.0000	0.0005	0.0022	0.0087	0.0289	0.0819	0.1975	0.4057
0.7102	1.0595	1.3469	1.4591	1.3469	1.0595	0.7102	0.4057	0.1975
0.0819	0.0289	0.0087	0.0022	0.0005	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0004	0.0020	0.0079	0.0263	0.0745	0.1795	0.3688
0.6457	0.9633	1.2246	1.3265	1.2246	0.9633	0.6457	0.3688	0.1795
0.0745	0.0263	0.0079	0.0020	0.0004	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0004	0.0018	0.0072	0.0238	0.0674	0.1625	0.3339
0.5845	0.8719	1.1084	1.2008	1.1084	0.8719	0.5845	0.3339	0.1625
0.0674	0.0238	0.0072	0.0018	0.0004	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0004	0.0017	0.0065	0.0215	0.0607	0.1465	0.3009
0.5267	0.7858	0.9989	1.0821	0.9989	0.7858	0.5267	0.3009	0.1465
0.0607	0.0215	0.0065	0.0017	0.0004	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0003	0.0015	0.0058	0.0193	0.0545	0.1314	0.2700
0.4727	0.7051	0.8964	0.9710	0.8964	0.7051	0.4727	0.2700	0.1314
0.0545	0.0193	0.0058	0.0015	0.0003	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0003	0.0013	0.0052	0.0172	0.0487	0.1174	0.2412
0.4223	0.6300	0.8009	0.8676	0.8009	0.6300	0.4223	0.2412	0.1174
0.0487	0.0172	0.0052	0.0013	0.0003	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0003	0.0012	0.0046	0.0153	0.0433	0.1045	0.2146
0.3757	0.5605	0.7126	0.7719	0.7126	0.5605	0.3757	0.2146	0.1045
0.0433	0.0153	0.0046	0.0012	0.0003	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0002	0.0010	0.0039	0.0130	0.0368	0.0888	0.1824
0.3194	0.4765	0.6057	0.6562	0.6057	0.4765	0.3194	0.1824	0.0888
0.0368	0.0130	0.0039	0.0010	0.0002	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0002	0.0008	0.0033	0.0110	0.0311	0.0749	0.1539
0.2695	0.4021	0.5111	0.5537	0.5111	0.4021	0.2695	0.1539	0.0749
0.0311	0.0110	0.0033	0.0008	0.0002	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0002	0.0007	0.0028	0.0092	0.0260	0.0628	0.1289
0.2257	0.3368	0.4281	0.4638	0.4281	0.3368	0.2257	0.1289	0.0628
0.0260	0.0092	0.0028	0.0007	0.0002	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0006	0.0023	0.0077	0.0216	0.0522	0.1072
0.1877	0.2800	0.3560	0.3856	0.3560	0.2800	0.1877	0.1072	0.0522
0.0216	0.0077	0.0023	0.0006	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0005	0.0019	0.0063	0.0179	0.0431	0.0885
0.1549	0.2311	0.2938	0.3183	0.2938	0.2311	0.1549	0.0885	0.0431
0.0179	0.0063	0.0019	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0004	0.0016	0.0052	0.0146	0.0353	0.0725
0.1270	0.1894	0.2408	0.2609	0.2408	0.1894	0.1270	0.0725	0.0353
0.0146	0.0052	0.0016	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0003	0.0013	0.0042	0.0119	0.0287	0.0590
0.1033	0.1541	0.1959	0.2123	0.1959	0.1541	0.1033	0.0590	0.0287
0.0119	0.0042	0.0013	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0001	0.0003	0.0010	0.0034	0.0096	0.0232	0.0477
0.0835	0.1245	0.1583	0.1715	0.1583	0.1245	0.0835	0.0477	0.0232
0.0096	0.0034	0.0010	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0002	0.0008	0.0027	0.0077	0.0186	0.0382
0.0670	0.0999	0.1270	0.1376	0.1270	0.0999	0.0670	0.0382	0.0186
0.0077	0.0027	0.0008	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0002	0.0007	0.0022	0.0062	0.0148	0.0305
0.0533	0.0796	0.1011	0.1096	0.1011	0.0796	0.0533	0.0305	0.0148
0.0062	0.0022	0.0007	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	[illegible]	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	[illegible]	0.0000
0.0000	0.0000	0.0000	0.0001	0.0005	0.0016	0.0046	[illegible]	0.0227

0.0397	0.0593	0.0754	0.0816	0.0754	0.0593	0.0397	0.0227	0.0110
0.0046	0.0016	0.0005	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0001	0.0004	0.0012	0.0034	0.0081	0.0167
0.0293	0.0437	0.0555	0.0602	0.0555	0.0437	0.0293	0.0167	0.0081
0.0034	0.0012	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0001	0.0003	0.0009	0.0025	0.0059	0.0122
0.0214	0.0319	0.0405	0.0439	0.0405	0.0319	0.0214	0.0122	0.0059
0.0025	0.0009	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0002	0.0006	0.0018	0.0043	0.0088
0.0154	0.0230	0.0292	0.0316	0.0292	0.0230	0.0154	0.0088	0.0043
0.0018	0.0006	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0001	0.0004	0.0013	0.0031	0.0063
0.0110	0.0164	0.0208	0.0226	0.0208	0.0164	0.0110	0.0063	0.0031
0.0013	0.0004	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0009	0.0022	0.0044
0.0078	0.0116	0.0147	0.0159	0.0147	0.0116	0.0078	0.0044	0.0022
0.0009	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0006	0.0015	0.0031
0.0054	0.0081	0.0103	0.0111	0.0103	0.0081	0.0054	0.0031	0.0015
0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0004	0.0010	0.0021
0.0037	0.0056	0.0071	0.0077	0.0071	0.0056	0.0037	0.0021	0.0010
0.0004	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0007	0.0015
0.0026	0.0038	0.0049	0.0053	0.0049	0.0038	0.0026	0.0015	0.0007
0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0005	0.0010
0.0017	0.0026	0.0033	0.0036	0.0033	0.0026	0.0017	0.0010	0.0005
0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		

(iv) CURRNY.DAT

2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724
2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724	2.8724
2.8724	2.8724	2.8722	2.8715	2.8684	2.8577	2.8253	2.7417	2.5576
2.2113	1.6553	0.8929	0.0000	-0.8929	-1.6553	-2.2113	-2.5576	-2.7417
-2.8253	-2.8577	-2.8684	-2.8715	-2.8722	-2.8724	-2.8724	-2.8724	-2.8724
-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724
-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724	-2.8724		
2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621
2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621	2.8621
2.8621	2.8621	2.8619	2.8611	2.8581	2.8474	2.8151	2.7318	2.5484
2.2034	1.6494	0.8897	0.0000	-0.8897	-1.6494	-2.2034	-2.5484	-2.7318
-2.8151	-2.8474	-2.8581	-2.8611	-2.8619	-2.8621	-2.8621	-2.8621	-2.8621
-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621
-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621	-2.8621		
2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312
2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312	2.8312
2.8312	2.8312	2.8311	2.8303	2.8274	2.8168	2.7848	2.7024	2.5209
2.1797	1.6316	0.8801	0.0000	-0.8801	-1.6316	-2.1797	-2.5209	-2.7024
-2.7848	-2.8168	-2.8274	-2.8303	-2.8311	-2.8312	-2.8312	-2.8312	-2.8312
-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312
-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312	-2.8312		
2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804
2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804	2.7804
2.7804	2.7804	2.7803	2.7796	2.7766	2.7662	2.7349	2.6539	2.4757
2.1406	1.6023	0.8643	0.0000	-0.8643	-1.6023	-2.1406	-2.4757	-2.6539
-2.7349	-2.7662	-2.7766	-2.7796	-2.7803	-2.7804	-2.7804	-2.7804	-2.7804
-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804
-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804	-2.7804		
2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105
2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105	2.7105
2.7105	2.7105	2.7103	2.7096	2.7067	2.6966	2.6660	2.5871	2.4134
2.0867	1.5620	0.8425	0.0000	-0.8425	-1.5620	-2.0867	-2.4134	-2.5871
-2.6660	-2.6966	-2.7067	-2.7096	-2.7103	-2.7105	-2.7105	-2.7105	-2.7105
-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105
-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105	-2.7105		
2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224
2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224	2.6224
2.6224	2.6224	2.6223	2.6216	2.6188	2.6090	2.5794	2.5031	2.3350
2.0189	1.5113	0.8152	0.0000	-0.8152	-1.5113	-2.0189	-2.3350	-2.5031
-2.5794	-2.6090	-2.6188	-2.6216	-2.6223	-2.6224	-2.6224	-2.6224	-2.6224
-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224
-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224	-2.6224		
2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177
2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177	2.5177
2.5177	2.5177	2.5175	2.5169	2.5142	2.5048	2.4764	2.4031	2.2418
1.9383	1.4509	0.7826	0.0000	-0.7826	-1.4509	-1.9383	-2.2418	-2.4031
-2.4764	-2.5048	-2.5142	-2.5169	-2.5175	-2.5177	-2.5177	-2.5177	-2.5177
-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177
-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177	-2.5177		
2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979
2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979	2.3979
2.3979	2.3979	2.3978	2.3972	2.3946	2.3857	2.3586	2.2888	2.1351
1.8461	1.3819	0.7454	0.0000	-0.7454	-1.3819	-1.8461	-2.1351	-2.2888
-2.3586	-2.3857	-2.3946	-2.3972	-2.3978	-2.3979	-2.3979	-2.3979	-2.3979
-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979
-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979	-2.3979		
2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649
2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649	2.2649
2.2649	2.2649	2.2648	2.2642	2.2616	2.2534	2.2278	2.1619	2.0167
1.7437	1.3053	0.7040	0.0000	-0.7040	-1.3053	-1.7437	-2.0167	-2.1619

-2.2276	-2.2534	-2.2618	-2.2642	-2.2648	-2.2649	-2.2649	-2.2649	-2.2649
-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649
-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649	-2.2649		
2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207
2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207	2.1207
2.1207	2.1207	2.1206	2.1200	2.1178	2.1099	2.0859	2.0242	1.8883
1.6327	1.2221	0.6592	0.0000	-0.6592	-1.2221	-1.6327	-1.8883	-2.0242
-2.0859	-2.1099	-2.1178	-2.1200	-2.1206	-2.1207	-2.1207	-2.1207	-2.1207
-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207
-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207	-2.1207		
1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674
1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674	1.9674
1.9674	1.9674	1.9672	1.9667	1.9647	1.9573	1.9351	1.8778	1.7517
1.5146	1.1338	0.6115	0.0000	-0.6115	-1.1338	-1.5146	-1.7517	-1.8778
-1.9351	-1.9573	-1.9647	-1.9667	-1.9672	-1.9674	-1.9674	-1.9674	-1.9674
-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674
-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674	-1.9674		
1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071
1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071	1.8071
1.8071	1.8070	1.8069	1.8065	1.8046	1.7978	1.7774	1.7248	1.6090
1.3912	1.0414	0.5617	0.0000	-0.5617	-1.0414	-1.3912	-1.6090	-1.7248
-1.7774	-1.7978	-1.8046	-1.8065	-1.8069	-1.8070	-1.8071	-1.8071	-1.8071
-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071
-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071	-1.8071		
1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420
1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420	1.6420
1.6420	1.6420	1.6419	1.6415	1.6397	1.6336	1.6151	1.5673	1.4620
1.2641	0.9463	0.5104	0.0000	-0.5104	-0.9463	-1.2641	-1.4620	-1.5673
-1.6151	-1.6336	-1.6397	-1.6415	-1.6419	-1.6420	-1.6420	-1.6420	-1.6420
-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420
-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420	-1.6420		
1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744
1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744	1.4744
1.4744	1.4744	1.4743	1.4739	1.4724	1.4669	1.4502	1.4073	1.3128
1.1351	0.8497	0.4583	0.0000	-0.4583	-0.8497	-1.1351	-1.3128	-1.4073
-1.4502	-1.4669	-1.4724	-1.4739	-1.4743	-1.4744	-1.4744	-1.4744	-1.4744
-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744
-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744	-1.4744		
1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064
1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064
1.3064	1.3064	1.3063	1.3059	1.3046	1.2997	1.2849	1.2469	1.1632
1.0057	0.7528	0.4061	0.0000	-0.4061	-0.7528	-1.0057	-1.1632	-1.2469
-1.2849	-1.2997	-1.3046	-1.3059	-1.3063	-1.3064	-1.3064	-1.3064	-1.3064
-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064
-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064	-1.3064		
1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399
1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399	1.1399
1.1399	1.1399	1.1398	1.1395	1.1383	1.1341	1.1212	1.0880	1.0150
0.8776	0.6569	0.3543	0.0000	-0.3543	-0.6569	-0.8776	-1.0150	-1.0880
-1.1212	-1.1341	-1.1383	-1.1395	-1.1398	-1.1399	-1.1399	-1.1399	-1.1399
-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399
-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399	-1.1399		
0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769
0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769	0.9769
0.9769	0.9769	0.9769	0.9766	0.9756	0.9720	0.9609	0.9325	0.8699
0.7521	0.5630	0.3037	0.0000	-0.3037	-0.5630	-0.7521	-0.8699	-0.9325
-0.9609	-0.9720	-0.9756	-0.9766	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769
-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769
-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769	-0.9769		
0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192

0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192	0.8192
0.8192	0.8192	0.8191	0.8189	0.8181	0.8150	0.8058	0.7819	0.7294
0.6307	0.4721	0.2546	0.0000	-0.2546	-0.4721	-0.6307	-0.7294	-0.7819
-0.8058	-0.8150	-0.8181	-0.8189	-0.8191	-0.8192	-0.8192	-0.8192	-0.8192
-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192
-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192	-0.8192		
0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682
0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682	0.6682
0.6682	0.6682	0.6681	0.6680	0.6673	0.6648	0.6572	0.6378	0.5949
0.5144	0.3851	0.2077	0.0000	-0.2077	-0.3851	-0.5144	-0.5949	-0.6378
-0.6572	-0.6648	-0.6673	-0.6680	-0.6681	-0.6682	-0.6682	-0.6682	-0.6682
-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682
-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682	-0.6682		
0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252
0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252	0.5252
0.5252	0.5252	0.5252	0.5251	0.5245	0.5226	0.5166	0.5013	0.4677
0.4044	0.3027	0.1633	0.0000	-0.1633	-0.3027	-0.4044	-0.4677	-0.5013
-0.5166	-0.5226	-0.5245	-0.5251	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252
-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252
-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252	-0.5252		
0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915
0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915	0.3915
0.3915	0.3915	0.3915	0.3914	0.3909	0.3895	0.3851	0.3737	0.3486
0.3014	0.2256	0.1217	0.0000	-0.1217	-0.2256	-0.3014	-0.3486	-0.3737
-0.3851	-0.3895	-0.3909	-0.3914	-0.3915	-0.3915	-0.3915	-0.3915	-0.3915
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0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678
0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678	0.2678
0.2678	0.2678	0.2678	0.2677	0.2674	0.2664	0.2634	0.2556	0.2384
0.2062	0.1543	0.0832	0.0000	-0.0832	-0.1543	-0.2062	-0.2384	-0.2556
-0.2634	-0.2664	-0.2674	-0.2677	-0.2678	-0.2678	-0.2678	-0.2678	-0.2678
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-0.2678	-0.2678	-0.2678	-0.2678	-0.2678	-0.2678	-0.2678		
0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548
0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548	0.1548
0.1548	0.1548	0.1548	0.1548	0.1546	0.1540	0.1523	0.1478	0.1378
0.1192	0.0892	0.0481	0.0000	-0.0481	-0.0892	-0.1192	-0.1378	-0.1478
-0.1523	-0.1540	-0.1546	-0.1548	-0.1548	-0.1548	-0.1548	-0.1548	-0.1548
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0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530
0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530
0.0530	0.0530	0.0530	0.0530	0.0529	0.0527	0.0521	0.0506	0.0472
0.0408	0.0305	0.0165	0.0000	-0.0165	-0.0305	-0.0408	-0.0472	-0.0506
-0.0521	-0.0527	-0.0529	-0.0530	-0.0530	-0.0530	-0.0530	-0.0530	-0.0530
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-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375
-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375	-0.0375
-0.0375	-0.0375	-0.0375	-0.0375	-0.0374	-0.0373	-0.0369	-0.0358	-0.0334
-0.0289	-0.0216	-0.0117	0.0000	0.0117	0.0216	0.0289	0.0334	0.0358
0.0369	0.0373	0.0374	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375		
-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166
-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166	-0.1166
-0.1166	-0.1166	-0.1166	-0.1165	-0.1164	-0.1160	-0.1147	-0.1113	-0.1038
-0.0897	-0.0672	-0.0362	0.0000	0.0362	0.0672	0.0897	0.1038	0.1113
0.1147	0.1160	0.1164	0.1165	0.1166	0.1166	0.1166	0.1166	0.1166

0.1166	0.1166	0.1166	0.1166	0.1166	0.1166	0.1166	0.1166	0.1166
0.1166	0.1166	0.1166	0.1166	0.1166	0.1166	0.1166		
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-0.1420	-0.1063	-0.0573	0.0000	0.0573	0.1063	0.1420	0.1642	0.1760
0.1814	0.1835	0.1842	0.1844	0.1844	0.1844	0.1844	0.1844	0.1844
0.1844	0.1844	0.1844	0.1844	0.1844	0.1844	0.1844	0.1844	0.1844
0.1844	0.1844	0.1844	0.1844	0.1844	0.1844	0.1844		
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-0.2414	-0.2414	-0.2414	-0.2414	-0.2411	-0.2402	-0.2375	-0.2304	-0.2150
-0.1859	-0.1391	-0.0750	0.0000	0.0750	0.1391	0.1859	0.2150	0.2304
0.2375	0.2402	0.2411	0.2414	0.2414	0.2414	0.2414	0.2414	0.2414
0.2414	0.2414	0.2414	0.2414	0.2414	0.2414	0.2414	0.2414	0.2414
0.2414	0.2414	0.2414	0.2414	0.2414	0.2414	0.2414		
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-0.2217	-0.1660	-0.0895	0.0000	0.0895	0.1660	0.2217	0.2565	0.2749
0.2833	0.2865	0.2876	0.2879	0.2880	0.2880	0.2880	0.2880	0.2880
0.2880	0.2880	0.2880	0.2880	0.2880	0.2880	0.2880	0.2880	0.2880
0.2880	0.2880	0.2880	0.2880	0.2880	0.2880	0.2880		
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-0.3248	-0.3248	-0.3248	-0.3247	-0.3243	-0.3231	-0.3195	-0.3100	-0.2892
-0.2500	-0.1872	-0.1010	0.0000	0.1010	0.1872	0.2500	0.2892	0.3100
0.3195	0.3231	0.3243	0.3247	0.3248	0.3248	0.3248	0.3248	0.3248
0.3248	0.3248	0.3248	0.3248	0.3248	0.3248	0.3248	0.3248	0.3248
0.3248	0.3248	0.3248	0.3248	0.3248	0.3248	0.3248		
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-0.3524	-0.3524	-0.3524	-0.3523	-0.3519	-0.3506	-0.3467	-0.3364	-0.3138
-0.2713	-0.2031	-0.1096	0.0000	0.1096	0.2031	0.2713	0.3138	0.3364
0.3467	0.3506	0.3519	0.3523	0.3524	0.3524	0.3524	0.3524	0.3524
0.3524	0.3524	0.3524	0.3524	0.3524	0.3524	0.3524	0.3524	0.3524
0.3524	0.3524	0.3524	0.3524	0.3524	0.3524	0.3524		
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-0.2862	-0.2142	-0.1155	0.0000	0.1155	0.2142	0.2862	0.3310	0.3548
0.3656	0.3698	0.3712	0.3716	0.3717	0.3717	0.3717	0.3717	0.3717
0.3717	0.3717	0.3717	0.3717	0.3717	0.3717	0.3717	0.3717	0.3717
0.3717	0.3717	0.3717	0.3717	0.3717	0.3717	0.3717		
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0.3771	0.3815	0.3829	0.3833	0.3834	0.3834	0.3834	0.3834	0.3834
0.3834	0.3834	0.3834	0.3834	0.3834	0.3834	0.3834	0.3834	0.3834
0.3834	0.3834	0.3834	0.3834	0.3834	0.3834	0.3834		
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-0.3884	-0.3884	-0.3884	-0.3883	-0.3879	-0.3864	-0.3821	-0.3707	-0.3458
-0.2990	-0.2238	-0.1207	0.0000	0.1207	0.2238	0.2990	0.3458	0.3707
0.3821	0.3864	0.3879	0.3883	0.3884	0.3884	0.3884	0.3884	0.3884
0.3884	0.3884	0.3884	0.3884	0.3884	0.3884	0.3884	0.3884	0.3884
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-0.3875	-0.3875	-0.3875	-0.3874	-0.3870	-0.3856	-0.3812	-0.3699	-0.3451
-0.2983	-0.2233	-0.1205	0.0000	0.1205	0.2233	0.2983	0.3451	0.3699
0.3812	0.3856	0.3870	0.3874	0.3875	0.3875	0.3875	0.3875	0.3875
0.3875	0.3875	0.3875	0.3875	0.3875	0.3875	0.3875	0.3875	0.3875
0.3875	0.3875	0.3875	0.3875	0.3875	0.3875	0.3875		
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0.3753	0.3797	0.3811	0.3815	0.3816	0.3816	0.3816	0.3816	0.3816
0.3816	0.3816	0.3816	0.3816	0.3816	0.3816	0.3816	0.3816	0.3816
0.3816	0.3816	0.3816	0.3816	0.3816	0.3816	0.3816		
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-0.3714	-0.3714	-0.3714	-0.3713	-0.3709	-0.3695	-0.3653	-0.3545	-0.3307
-0.2860	-0.2141	-0.1155	0.0000	0.1155	0.2141	0.2860	0.3307	0.3545
0.3653	0.3695	0.3709	0.3713	0.3714	0.3714	0.3714	0.3714	0.3714
0.3714	0.3714	0.3714	0.3714	0.3714	0.3714	0.3714	0.3714	0.3714
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0.3519	0.3560	0.3573	0.3577	0.3578	0.3578	0.3578	0.3578	0.3578
0.3578	0.3578	0.3578	0.3578	0.3578	0.3578	0.3578	0.3578	0.3578
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0.3359	0.3397	0.3410	0.3413	0.3414	0.3414	0.3414	0.3414	0.3414
0.3414	0.3414	0.3414	0.3414	0.3414	0.3414	0.3414	0.3414	0.3414
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-0.2487	-0.1862	-0.1004	0.0000	0.1004	0.1862	0.2487	0.2876	0.3083
0.3177	0.3214	0.3226	0.3229	0.3230	0.3230	0.3230	0.3230	0.3230
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-0.3031	-0.3031	-0.3031	-0.3030	-0.3027	-0.3016	-0.2982	-0.2893	-0.2699
-0.2334	-0.1747	-0.0942	0.0000	0.0942	0.1747	0.2334	0.2699	0.2893
0.2982	0.3016	0.3027	0.3030	0.3031	0.3031	0.3031	0.3031	0.3031
0.3031	0.3031	0.3031	0.3031	0.3031	0.3031	0.3031	0.3031	0.3031
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-0.2753	-0.2753	-0.2753	-0.2753	-0.2753	-0.2753	-0.2753	-0.2753	-0.2753
-0.2753	-0.2753	-0.2753	-0.2752	-0.2749	-0.2739	-0.2708	-0.2627	-0.2451
-0.2119	-0.1586	-0.0856	0.0000	0.0856	0.1586	0.2119	0.2451	0.2627
0.2708	0.2739	0.2749	0.2752	0.2753	0.2753	0.2753	0.2753	0.2753
0.2753	0.2753	0.2753	0.2753	0.2753	0.2753	0.2753	0.2753	0.2753
0.2753	0.2753	0.2753	0.2753	0.2753	0.2753	0.2753		
-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469
-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469	-0.2469
-0.2469	-0.2469	-0.2469	-0.2468	-0.2465	-0.2456	-0.2428	-0.2356	-0.2198
-0.1901	-0.1423	-0.0767	0.0000	0.0767	0.1423	0.1901	0.2198	0.2356
0.2428	0.2456	0.2465	0.2468	0.2469	0.2469	0.2469	0.2469	0.2469
0.2469	0.2469	0.2469	0.2469	0.2469	0.2469	0.2469	0.2469	0.2469

0.2469	0.2469	0.2469	0.2469	0.2469	0.2469	0.2469		
-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188
-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188	-0.2188
-0.2188	-0.2188	-0.2188	-0.2188	-0.2185	-0.2177	-0.2152	-0.2089	-0.1948
-0.1685	-0.1261	-0.0680	0.0000	0.0680	0.1261	0.1685	0.1948	0.2089
0.2152	0.2177	0.2185	0.2188	0.2188	0.2188	0.2188	0.2188	0.2188
0.2188	0.2188	0.2188	0.2188	0.2188	0.2188	0.2188	0.2188	0.2188
0.2188	0.2188	0.2188	0.2188	0.2188	0.2188	0.2188		
-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918
-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918	-0.1918
-0.1918	-0.1918	-0.1918	-0.1918	-0.1916	-0.1909	-0.1887	-0.1831	-0.1708
-0.1477	-0.1106	-0.0596	0.0000	0.0596	0.1106	0.1477	0.1708	0.1831
0.1887	0.1909	0.1916	0.1918	0.1918	0.1918	0.1918	0.1918	0.1918
0.1918	0.1918	0.1918	0.1918	0.1918	0.1918	0.1918	0.1918	0.1918
0.1918	0.1918	0.1918	0.1918	0.1918	0.1918	0.1918		
-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664
-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664	-0.1664
-0.1664	-0.1664	-0.1664	-0.1664	-0.1662	-0.1656	-0.1637	-0.1588	-0.1482
-0.1281	-0.0959	-0.0517	0.0000	0.0517	0.0959	0.1281	0.1482	0.1588
0.1637	0.1656	0.1662	0.1664	0.1664	0.1664	0.1664	0.1664	0.1664
0.1664	0.1664	0.1664	0.1664	0.1664	0.1664	0.1664	0.1664	0.1664
0.1664	0.1664	0.1664	0.1664	0.1664	0.1664	0.1664		
-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429
-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429	-0.1429
-0.1429	-0.1429	-0.1429	-0.1429	-0.1427	-0.1422	-0.1406	-0.1364	-0.1272
-0.1100	-0.0824	-0.0444	0.0000	0.0444	0.0824	0.1100	0.1272	0.1364
0.1406	0.1422	0.1427	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429
0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429
0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429		
-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215
-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215	-0.1215
-0.1215	-0.1215	-0.1215	-0.1215	-0.1214	-0.1209	-0.1195	-0.1160	-0.1082
-0.0936	-0.0700	-0.0378	0.0000	0.0378	0.0700	0.0936	0.1082	0.1160
0.1195	0.1209	0.1214	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215
0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215
0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215		
-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024
-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024	-0.1024
-0.1024	-0.1024	-0.1024	-0.1024	-0.1022	-0.1019	-0.1007	-0.0977	-0.0912
-0.0788	-0.0590	-0.0318	0.0000	0.0318	0.0590	0.0788	0.0912	0.0977
0.1007	0.1019	0.1022	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024
0.1024	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024
0.1024	0.1024	0.1024	0.1024	0.1024	0.1024	0.1024		
-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855
-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855	-0.0855
-0.0855	-0.0855	-0.0855	-0.0854	-0.0854	-0.0850	-0.0841	-0.0816	-0.0761
-0.0656	-0.0493	-0.0266	0.0000	0.0266	0.0493	0.0656	0.0761	0.0816
0.0841	0.0850	0.0854	0.0854	0.0855	0.0855	0.0855	0.0855	0.0855
0.0855	0.0855	0.0855	0.0855	0.0855	0.0855	0.0855	0.0855	0.0855
0.0855	0.0855	0.0855	0.0855	0.0855	0.0855	0.0855		
-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707
-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707	-0.0707
-0.0707	-0.0707	-0.0707	-0.0707	-0.0706	-0.0704	-0.0696	-0.0675	-0.0630
-0.0544	-0.0408	-0.0220	0.0000	0.0220	0.0408	0.0544	0.0630	0.0675
0.0696	0.0704	0.0706	0.0707	0.0707	0.0707	0.0707	0.0707	0.0707
0.0707	0.0707	0.0707	0.0707	0.0707	0.0707	0.0707	0.0707	0.0707
0.0707	0.0707	0.0707	0.0707	0.0707	0.0707	0.0707		
-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551
-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0551
-0.0551	-0.0551	-0.0551	-0.0551	-0.0551	-0.0548	-0.0542	-0.0526	-0.0491

-0.0424	-0.0318	-0.0171	0.0000	0.0171	0.0318	0.0424	0.0491	0.0526
0.0542	0.0548	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551
0.0551	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551
0.0551	0.0551	0.0551	0.0551	0.0551	0.0551	0.0551		
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-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424
-0.0424	-0.0424	-0.0424	-0.0424	-0.0423	-0.0422	-0.0417	-0.0405	-0.0378
-0.0326	-0.0244	-0.0132	0.0000	0.0132	0.0244	0.0326	0.0378	0.0405
0.0417	0.0422	0.0423	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424		
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-0.0322	-0.0322	-0.0322	-0.0322	-0.0322	-0.0322	-0.0322	-0.0322	-0.0322
-0.0322	-0.0322	-0.0322	-0.0322	-0.0322	-0.0320	-0.0317	-0.0307	-0.0287
-0.0248	-0.0186	-0.0100	0.0000	0.0100	0.0186	0.0248	0.0287	0.0307
0.0317	0.0320	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322
0.0322	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322
0.0322	0.0322	0.0322	0.0322	0.0322	0.0322	0.0322		
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-0.0241	-0.0241	-0.0241	-0.0241	-0.0241	-0.0241	-0.0241	-0.0241	-0.0241
-0.0241	-0.0241	-0.0241	-0.0241	-0.0241	-0.0240	-0.0237	-0.0230	-0.0215
-0.0186	-0.0139	-0.0075	0.0000	0.0075	0.0139	0.0186	0.0215	0.0230
0.0237	0.0240	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241
0.0241	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241
0.0241	0.0241	0.0241	0.0241	0.0241	0.0241	0.0241		
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-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0179
-0.0179	-0.0179	-0.0179	-0.0179	-0.0179	-0.0178	-0.0176	-0.0171	-0.0159
-0.0138	-0.0103	-0.0056	0.0000	0.0056	0.0103	0.0138	0.0159	0.0171
0.0176	0.0178	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179
0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179
0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179		
-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131
-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131
-0.0131	-0.0131	-0.0131	-0.0131	-0.0131	-0.0130	-0.0129	-0.0125	-0.0116
-0.0101	-0.0075	-0.0041	0.0000	0.0041	0.0075	0.0101	0.0116	0.0125
0.0129	0.0130	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131
0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131
0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131		
-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094
-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094
-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0094	-0.0093	-0.0090	-0.0084
-0.0073	-0.0054	-0.0029	0.0000	0.0029	0.0054	0.0073	0.0084	0.0090
0.0093	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094
0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094
0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094		
-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067
-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067
-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0067	-0.0066	-0.0064	-0.0060
-0.0052	-0.0039	-0.0021	0.0000	0.0021	0.0039	0.0052	0.0060	0.0064
0.0066	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067		
-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048
-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0048
-0.0048	-0.0048	-0.0048	-0.0048	-0.0048	-0.0047	-0.0047	-0.0045	-0.0042
-0.0037	-0.0027	-0.0015	0.0000	0.0015	0.0027	0.0037	0.0042	0.0045
0.0047	0.0047	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048		

-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033
-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033
-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0033	-0.0032	-0.0030
-0.0026	-0.0019	-0.0010	0.0000	0.0010	0.0019	0.0026	0.0030	0.0032
0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033		

(v) LOC.DAT

```
  0
  0.000    15.000    30.000    45.000    60.000    75.000    90.000   105.000
120.000   135.000   150.000   165.000   180.000   195.000   210.000   225.000
240.000   255.000   270.000   285.000   300.000   315.000   330.000   345.000
360.000   375.000   390.000   405.000   420.000   435.000   450.000   465.000
480.000   495.000   510.000   525.000   540.000   555.000   570.000   585.000
600.000   620.000   640.000   660.000   680.000   700.000   720.000   740.000
760.000   780.000   800.000   825.000   850.000   875.000   900.000   925.000
950.000   975.000  1000.000  1025.000  1050.000
  0
-500.000  -480.000  -460.000  -440.000  -420.000  -400.000  -380.000  -360.000
-340.000  -320.000  -300.000  -280.000  -260.000  -240.000  -220.000  -200.000
-180.000  -160.000  -140.000  -120.000  -100.000   -90.000   -80.000   -70.000
 -60.000   -50.000   -40.000   -30.000   -20.000   -10.000     0.000    10.000
  20.000    30.000    40.000    50.000    60.000    70.000    80.000    90.000
 100.000   120.000   140.000   160.000   180.000   200.000   220.000   240.000
 260.000   280.000   300.000   320.000   340.000   360.000   380.000   400.000
 420.000   440.000   460.000   480.000   500.000
```

(vi) OUT01.DAT

CURRENT-WAVE INTERACTION

AMPLITUDE = 1.000 PERIOD = 8.000

ANGLE = 0.000 GRAVITY = 32.200 TIDE = 0.000

REFERENCE POINT = (1000.000 , -400.000)

N = 81 NN = 100 M = 100

DSIG = 10.000 DRHO = 10.000 IOPTCO = 2 IOPTBU = 0 IOPTBD = 0

IBACKD = 1 IREALD = 2 IBREAK = 1 ICURRN = 1

IFRCT = 0 XDAMP = 1000.000 FRCT = 0.1000E-01 IBKWTR = 0

SECTION FROM (150.000 , -200.000) TO (150.000 , 200.000)

X - COORD.	Y - COORD.	AMPLITUDE	DEPTH	PHASE VALUE
150.0000	-390.0000	1.1399	3.0000	39.2450
150.0000	-200.0000	1.1695	3.0000	39.1427
150.0000	-190.0000	1.1750	3.0000	39.1645
150.0000	-180.0000	1.1682	3.0000	39.1382
150.0000	-170.0000	1.0050	3.0000	39.1851
150.0000	-160.0000	0.9783	3.0000	39.1605
150.0000	-150.0000	1.1638	3.0000	39.0409
150.0000	-140.0000	1.1373	3.0000	38.9600
150.0000	-130.0000	1.1638	3.0000	38.9872
150.0000	-120.0000	1.1036	3.0000	39.0674
150.0000	-110.0000	1.0413	3.0000	39.1610
150.0000	-100.0000	1.0081	3.0000	39.2290
150.0000	-90.0000	0.9685	3.0000	39.2860
150.0000	-80.0000	0.9283	3.0000	39.3504
150.0000	-70.0000	0.8710	3.0000	39.4191
150.0000	-60.0000	0.7933	3.0000	39.5248
150.0000	-50.0000	0.6944	3.0000	39.7000
150.0000	-40.0000	0.5876	3.0000	40.0292
150.0000	-30.0000	0.5294	3.0000	40.0801
150.0000	-20.0000	0.7151	3.0000	41.4503
150.0000	-10.0000	1.1204	3.0000	41.9985
150.0000	0.0000	1.3172	3.0000	42.1173
150.0000	10.0000	1.1189	3.0000	42.0041
150.0000	20.0000	0.7096	3.0000	41.4614
150.0000	30.0000	0.5204	3.0000	40.6839
150.0000	40.0000	0.5812	3.0000	40.0236
150.0000	50.0000	0.6912	3.0000	39.6946
150.0000	60.0000	0.7921	3.0000	39.5202
150.0000	70.0000	0.8712	3.0000	39.4156
150.0000	80.0000	0.9292	3.0000	39.3478
150.0000	90.0000	0.9700	3.0000	39.2843
150.0000	100.0000	1.0099	3.0000	39.2279
150.0000	110.0000	1.0431	3.0000	39.1606
150.0000	120.0000	1.1052	3.0000	39.0676

150.0000	130.0000	1.1651	3.0000	38.9677
150.0000	140.0000	1.1382	3.0000	38.9606
150.0000	150.0000	1.1644	3.0000	39.0415
150.0000	160.0000	0.9766	3.0000	39.1610
150.0000	170.0000	1.0052	3.0000	39.1855
150.0000	180.0000	1.1663	3.0000	39.1385
150.0000	190.0000	1.1752	3.0000	39.1649
150.0000	200.0000	1.1695	3.0000	39.1431
-99.00000	-99.00000	-99.00000		

Appendix E

a) Input/Output Data Files for Waves Around
a Perpendicular Breakwater

(i) IN.DAT
(ii) DEPTH.DAT
(iii) LOC.DAT
(iv) OUT01.DAT

b) Input/Output Data Files for Waves Around
an Inclined Breakwater

(v) IN.DAT
(vi) OUT01.DAT

Note: DEPTH.DAT and LOC.DAT are the same as in (a)

c) Input/Output Data Files for Waves Around Two
Breakwaters

(vii) IN.DAT
(viii) DEPTH.DAT
(ix) LOC.DAT
(x) OUT01.DAT

(i) IN.DAT

```
          0
          0            0
   1.000000     1.000000      20.00000      32.20000     0.0000000E+00
          7            2
   15.00000    -25.00000     0.2500000     0.2500000               250
        260 5.0000001E-02 0.0000000E+00   1.000000    0.0000000E+00
          1
          2
          2
          0            0
          0 0.0000000E+00 0.0000000E+00
          0
          0
          1
          2   15.00000    0.0000000E+00 0.0000000E+00 0.0000000E+00
CERC PERPENDICULAR BREAKWATER
          2
   12.50000    -15.00000      12.50000      20.00000
   9.000000    -15.00000      9.000000      20.00000
```

(ii) DEPTH.DAT

```
0
0.0     0.0
0.5     0.5
0.75    0.75
0.9     0.9
1.0     1.0
1.0     1.0
1.0     1.0
```

(iii) LOC.DAT

```
0
0.0  10.0  15.0  18.0  20.0  21.0  30.0
0
-50. 50.
```

(iv) OUT01.DAT

CERC PERPENDICULAR BREAKWATER

AMPLITUDE = 1.000 PERIOD = 1.000

ANGLE = 0.000 GRAVITY = 32.200 TIDE = 0.000

REFERENCE POINT = (15.000 , -25.000)

N = 250 NN = 260 M = 260

DSIG = 0.250 DRHO = 0.250 IOPTCO = 0 IOPTBU = 0 IOPTBD = 0

IBACKD = 2 IREALD = 2 IBREAK = 0 ICURRN = 0

IFRCT = 0 XDAMP = 0.000 FRCT = 0.0000E+00 IBKWTR = 1

BREAKWATER NO. = 1 POINTS ON THE BREAKWATER = 2

15.0000 0.0000 0.0000 0.0000

SECTION FROM (12.500 , -15.000) TO (12.500 , 20.000)

X - COORD.	Y - COORD.	AMPLITUDE	DEPTH	PHASE VALUE
12.5000	-14.9976	0.9962	0.6250	8.4732
12.5000	-14.7475	0.9963	0.6250	8.5922
12.5000	-14.4974	0.9963	0.6250	8.7112
12.5000	-14.2475	0.9962	0.6250	8.8301
12.5000	-13.9974	0.9961	0.6250	8.9488
12.5000	-13.7476	0.9960	0.6250	9.0674
12.5000	-13.4974	0.9959	0.6250	9.1858
12.5000	-13.2476	0.9960	0.6250	9.3042
12.5000	-12.9977	0.9961	0.6250	9.4225
12.5000	-12.7476	0.9962	0.6250	9.5408
12.5000	-12.4977	0.9963	0.6250	9.6592
12.5000	-12.2476	0.9965	0.6250	9.7776
12.5000	-11.9975	0.9965	0.6250	9.8960
12.5000	-11.7476	0.9964	0.6250	10.0144
12.5000	-11.4975	0.9962	0.6250	10.1327
12.5000	-11.2476	0.9960	0.6250	10.2510
12.5000	-10.9975	0.9956	0.6250	10.3691
12.5000	-10.7476	0.9953	0.6250	10.4872
12.5000	-10.4975	0.9949	0.6250	10.6053
12.5000	-10.2475	0.9946	0.6250	10.7232
12.5000	-9.9976	0.9943	0.6250	10.8412
12.5000	-9.7476	0.9941	0.6250	10.9592
12.5000	-9.4976	0.9938	0.6250	11.0773
12.5000	-9.2476	0.9936	0.6250	11.1955
12.5000	-8.9976	0.9933	0.6250	11.3137
12.5000	-8.7476	0.9930	0.6250	11.4319
12.5000	-8.4976	0.9926	0.6250	11.5502
12.5000	-8.2476	0.9922	0.6250	11.6684
12.5000	-7.9976	0.9918	0.6250	11.7866

12.5000	-7.7476	0.9915	0.6250	11.9048
12.5000	-7.4976	0.9912	0.6250	12.0230
12.5000	-7.2476	0.9910	0.6250	12.1413
12.5000	-6.9976	0.9908	0.6250	12.2597
12.5000	-6.7475	0.9907	0.6250	12.3781
12.5000	-6.4977	0.9907	0.6250	12.4966
12.5000	-6.2477	0.9906	0.6250	12.6152
12.5000	-5.9975	0.9905	0.6250	12.7339
12.5000	-5.7477	0.9904	0.6250	12.8527
12.5000	-5.4977	0.9903	0.6250	12.9715
12.5000	-5.2476	0.9902	0.6250	13.0904
12.5000	-4.9976	0.9902	0.6250	13.2092
12.5000	-4.7476	0.9902	0.6250	13.3282
12.5000	-4.4976	0.9902	0.6250	13.4471
12.5000	-4.2476	0.9903	0.6250	13.5662
12.5000	-3.9976	0.9904	0.6250	13.6854
12.5000	-3.7476	0.9908	0.6250	13.8049
12.5000	-3.4976	0.9918	0.6250	13.9230
12.5000	-3.2476	0.9870	0.6250	14.0403
12.5000	-2.9976	0.9834	0.6250	14.1741
12.5000	-2.7476	1.0133	0.6250	14.2978
12.5000	-2.4976	1.0205	0.6250	14.3727
12.5000	-2.2476	0.9746	0.6250	14.4696
12.5000	-1.9976	0.9229	0.6250	14.6141
12.5000	-1.7476	0.9063	0.6250	14.8087
12.5000	-1.4976	0.9453	0.6250	14.9996
12.5000	-1.2476	1.0303	0.6250	15.1556
12.5000	-0.9976	1.1334	0.6250	15.2604
12.5000	-0.7476	1.2329	0.6250	15.3239
12.5000	-0.4976	1.3145	0.6250	15.3579
12.5000	-0.2476	1.3683	0.6250	15.3685
12.5000	-0.1930	1.3779	0.6250	15.3697
12.5000	0.2524	0.7062	0.6250	16.0831
12.5000	0.5024	0.7128	0.6250	16.1039
12.5000	0.7524	0.7249	0.6250	16.1385
12.5000	1.0024	0.7424	0.6250	16.1851
12.5000	1.2524	0.7652	0.6250	16.2442
12.5000	1.5024	0.7917	0.6250	16.3160
12.5000	1.7524	0.8204	0.6250	16.3987
12.5000	2.0024	0.8513	0.6250	16.4908
12.5000	2.2524	0.8836	0.6250	16.5926
12.5000	2.5024	0.9156	0.6250	16.7036
12.5000	2.7524	0.9457	0.6250	16.8218
12.5000	3.0024	0.9737	0.6250	16.9456
12.5000	3.2524	0.9995	0.6250	17.0745
12.5000	3.5024	1.0218	0.6250	17.2087
12.5000	3.7524	1.0387	0.6250	17.3470
12.5000	4.0024	1.0493	0.6250	17.4873
12.5000	4.2525	1.0539	0.6250	17.6276
12.5000	4.5024	1.0535	0.6250	17.7671
12.5000	4.7525	1.0482	0.6250	17.9053
12.5000	5.0025	1.0381	0.6250	18.0412
12.5000	5.2525	1.0237	0.6250	18.1731
12.5000	5.5024	1.0067	0.6250	18.2991
12.5000	5.7524	0.9899	0.6250	18.4187
12.5000	6.0024	0.9759	0.6250	18.5326
12.5000	6.2524	0.9659	0.6250	18.6425
12.5000	6.5024	0.9606	0.6250	18.7502
12.5000	6.7524	0.9602	0.6250	18.8571
12.5000	7.0025	0.9648	0.6250	18.9649

12.5000	7.2525	0.9740	0.6250	19.0759
12.5000	7.5025	0.9864	0.6250	19.1919
12.5000	7.7525	0.9993	0.6250	19.3137
12.5000	8.0025	1.0101	0.6250	19.4407
12.5000	8.2525	1.0170	0.6250	19.5709
12.5000	8.5025	1.0194	0.6250	19.7022
12.5000	8.7525	1.0176	0.6250	19.8330
12.5000	9.0025	1.0125	0.6250	19.9620
12.5000	9.2525	1.0047	0.6250	20.0883
12.5000	9.5025	0.9953	0.6250	20.2111
12.5000	9.7525	0.9859	0.6250	20.3294
12.5000	10.0024	0.9786	0.6250	20.4435
12.5000	10.2523	0.9754	0.6250	20.5545
12.5000	10.5024	0.9775	0.6250	20.6651
12.5000	10.7525	0.9843	0.6250	20.7784
12.5000	11.0024	0.9936	0.6250	20.8964
12.5000	11.2525	1.0027	0.6250	21.0193
12.5000	11.5024	1.0092	0.6250	21.1459
12.5000	11.7523	1.0120	0.6250	21.2743
12.5000	12.0024	1.0111	0.6250	21.4026
12.5000	12.2523	1.0074	0.6250	21.5291
12.5000	12.5024	1.0018	0.6250	21.6533
12.5000	12.7523	0.9956	0.6250	21.7749
12.5000	13.0024	0.9898	0.6250	21.8936
12.5000	13.2525	0.9856	0.6250	22.0095
12.5000	13.5024	0.9841	0.6250	22.1236
12.5000	13.7525	0.9862	0.6250	22.2375
12.5000	14.0024	0.9918	0.6250	22.3533
12.5000	14.2525	0.9996	0.6250	22.4726
12.5000	14.5024	1.0071	0.6250	22.5961
12.5000	14.7525	1.0117	0.6250	22.7230
12.5000	15.0024	1.0121	0.6250	22.8512
12.5000	15.2525	1.0082	0.6250	22.9783
12.5000	15.5026	1.0018	0.6250	23.1019
12.5000	15.7525	0.9951	0.6250	23.2210
12.5000	16.0026	0.9906	0.6250	23.3364
12.5000	16.2525	0.9894	0.6250	23.4503
12.5000	16.5026	0.9917	0.6250	23.5650
12.5000	16.7525	0.9963	0.6250	23.6822
12.5000	17.0026	1.0015	0.6250	23.8023
12.5000	17.2527	1.0059	0.6250	23.9247
12.5000	17.5026	1.0084	0.6250	24.0482
12.5000	17.7527	1.0088	0.6250	24.1719
12.5000	18.0023	1.0073	0.6250	24.2949
12.5000	18.2524	1.0043	0.6250	24.4168
12.5000	18.5023	1.0005	0.6250	24.5372
12.5000	18.7527	0.9970	0.6250	24.6560
12.5000	19.0025	0.9945	0.6250	24.7733
12.5000	19.2524	0.9939	0.6250	24.8893
12.5000	19.5025	0.9957	0.6250	25.0051
12.5000	19.7524	0.9996	0.6250	25.1220
12.5000	19.8069	1.0003	0.6250	25.1474
-99.00000	-99.00000	-99.00000		

(v) IN.DAT

```
          2
          0          0
1.000000       1.000000       30.00000       32.20000       0.0000000E+00
          7          2
15.00000      -25.00000       0.2500000      0.25000000              201
         60  5.0000001E-02  0.0000000E+00  1.000000     0.0000000E+00
          1
          2
          2
          0          0
          0  0.0000000E+00  0.0000000E+00
          0
          0
          1
          2   15.00000      0.0000000E+00  0.0000000E+00  -8.66
CERC INCLINED BREAKWATER
          4
12.00000      -15.00000       12.00000       20.00000
10.00000      -15.00000       10.00000       20.00000
 8.00000      -15.00000        8.00000       20.00000
 6.00000      -15.00000        6.00000       20.00000
```

(vi) OUT01.DAT

CERC INCLINED BREAKWATER

AMPLITUDE = 1.000 PERIOD = 1.000

ANGLE = 0.000 GRAVITY = 32.200 TIDE = 0.000

REFERENCE POINT = (15.000 , -25.000)

N = 201 NN = 60 M = 60

DSIG = 0.250 DRHO = 0.250 IOPTCO = 2 IOPTBU = 0 IOPTBD = 0

IBACKD = 2 IREALD = 2 IBREAK = 0 ICURRN = 0

IFRCT = 0 XDAMP = 0.000 FRCT = 0.0000E+00 IBKWTR = 1

BREAKWATER NO. = 1 POINTS ON THE BREAKWATER = 2

15.0000 0.0000 0.0000 -8.6600

SECTION FROM (12.000 , -15.000) TO (12.000 , 20.000)

X - COORD.	Y - COORD.	AMPLITUDE	DEPTH	PHASE VALUE
12.0000	-15.0000	0.9836	0.6000	11.1540
12.0000	-14.7500	0.9836	0.6000	11.3276
12.0000	-14.5000	0.9836	0.6000	11.5012
12.0000	-14.2500	0.9836	0.6000	11.6748
12.0000	-14.0000	0.9836	0.6000	11.8484
12.0000	-13.7500	0.9836	0.6000	12.0220
12.0000	-13.5000	0.9836	0.6000	12.1956
12.0000	-13.2500	0.9836	0.6000	12.3691
12.0000	-13.0000	0.9836	0.6000	12.5427
12.0000	-12.7500	0.9836	0.6000	12.7163
12.0000	-12.5000	0.9836	0.6000	12.8899
12.0000	-12.2500	0.9836	0.6000	13.0635
12.0000	-12.0000	0.9836	0.6000	13.2371
12.0000	-11.7500	0.9836	0.6000	13.4106
12.0000	-11.5001	0.9836	0.6000	13.5842
12.0000	-11.2500	0.9836	0.6000	13.7578
12.0000	-11.0000	0.9836	0.6000	13.9314
12.0000	-10.7500	0.9837	0.6000	14.1050
12.0000	-10.5000	0.9837	0.6000	14.2786
12.0000	-10.2500	0.9837	0.6000	14.4521
12.0000	-10.0000	0.9836	0.6000	14.6257
12.0000	-9.7500	0.9836	0.6000	14.7993
12.0000	-9.5000	0.9836	0.6000	14.9730
12.0000	-9.2500	0.9838	0.6000	15.1467
12.0000	-9.0000	0.9841	0.6000	15.3201
12.0000	-8.7500	0.9841	0.6000	15.4931
12.0000	-8.5000	0.9833	0.6000	15.6661
12.0000	-8.2500	0.9819	0.6000	15.8402
12.0000	-8.0000	0.9812	0.6000	16.0162

12.0000	-7.7500	0.9838	0.6000	16.1930
12.0000	-7.5000	0.9901	0.6000	16.3659
12.0000	-7.2500	0.9949	0.6000	16.5308
12.0000	-7.0000	0.9884	0.6000	16.6906
12.0000	-6.7500	0.9657	0.6000	16.8602
12.0000	-6.5000	0.9420	0.6000	17.0598
12.0000	-6.2500	0.9541	0.6000	17.2846
12.0000	-6.0000	1.0217	0.6000	17.4814
12.0000	-5.7500	1.1031	0.6000	17.6006
12.0000	-5.5000	1.1148	0.6000	17.6518
12.0000	-5.2500	0.9929	0.6000	17.6987
12.0000	-5.0000	0.7602	0.6000	17.8864
12.0000	-4.7500	0.6478	0.6000	18.4454
12.0000	-4.5000	0.9187	0.6000	18.9125
12.0000	-4.2500	1.3161	0.6000	18.9842
12.0000	-4.0000	1.5884	0.6000	18.8934
12.0000	-3.7500	1.6324	0.6000	18.7446
12.0000	-3.5000	1.4273	0.6000	18.5703
12.0000	-3.2500	0.9966	0.6000	18.3681
12.0000	-3.0000	0.3888	0.6000	18.0389
12.0000	-2.7500	0.3640	0.6000	21.4712
12.0000	-2.5000	1.1069	0.6000	21.0952
12.0000	-2.2500	1.7664	0.6000	20.8515
12.0000	-2.0000	2.2389	0.6000	20.6199
12.0000	-1.5000	0.3545	0.6000	23.3837
12.0000	-1.2500	0.3495	0.6000	23.2271
12.0000	-1.0000	0.3422	0.6000	23.0879
12.0000	-0.7500	0.3589	0.6000	22.9057
12.0000	-0.5000	0.3743	0.6000	22.8274
12.0000	-0.2500	0.3760	0.6000	22.7802
12.0000	0.0000	0.3952	0.6000	22.6742
12.0000	0.2500	0.4136	0.6000	22.6942
12.0000	0.5000	0.4215	0.6000	22.6452
12.0000	0.7500	0.4544	0.6000	22.6649
12.0000	1.0000	0.4648	0.6000	22.6867
12.0000	1.2500	0.5014	0.6000	22.6953
12.0000	1.5000	0.5469	0.6000	22.7661
12.0000	1.7500	0.5846	0.6000	22.8501
12.0000	2.0000	0.6323	0.6000	22.9488
12.0000	2.2500	0.6760	0.6000	23.0786
12.0000	2.5000	0.7076	0.6000	23.2062
12.0000	2.7500	0.7514	0.6000	23.3229
12.0000	3.0000	0.8162	0.6000	23.4648
12.0000	3.2500	0.8767	0.6000	23.6421
12.0000	3.5000	0.9167	0.6000	23.8272
12.0000	3.7500	0.9518	0.6000	23.9998
12.0000	4.0000	1.0041	0.6000	24.1732
12.0000	4.2500	1.0694	0.6000	24.3735
12.0000	4.5000	1.1197	0.6000	24.6058
12.0000	4.7500	1.1307	0.6000	24.8532
12.0000	5.0000	1.0987	0.6000	25.0913
12.0000	5.2500	1.0403	0.6000	25.2999
12.0000	5.5000	0.9825	0.6000	25.4707
12.0000	5.7500	0.9472	0.6000	25.6133
12.0000	6.0000	0.9403	0.6000	25.7498
12.0000	6.2500	0.9525	0.6000	25.8985
12.0000	6.5000	0.9699	0.6000	26.0636
12.0000	6.7500	0.9832	0.6000	26.2400
12.0000	7.0000	0.9895	0.6000	26.4206
12.0000	7.2500	0.9901	0.6000	26.6006

12.0000	7.5000	0.9880	0.6000	26.7778
12.0000	7.7500	0.9855	0.6000	26.9525
12.0000	8.0000	0.9838	0.6000	27.1257
12.0000	8.2500	0.9831	0.6000	27.2984
12.0000	8.5000	0.9830	0.6000	27.4713
12.0000	8.7500	0.9832	0.6000	27.6445
12.0000	9.0000	0.9835	0.6000	27.8180
12.0000	9.2500	0.9836	0.6000	27.9916
12.0000	9.5000	0.9837	0.6000	28.1653
12.0000	9.7500	0.9837	0.6000	28.3389
12.0000	10.0000	0.9837	0.6000	28.5125
12.0000	10.2500	0.9837	0.6000	28.6861
12.0000	10.5000	0.9836	0.6000	28.8597
12.0000	10.7500	0.9836	0.6000	29.0333
12.0000	11.0000	0.9836	0.6000	29.2069
12.0000	11.2500	0.9836	0.6000	29.3805
12.0000	11.5001	0.9836	0.6000	29.5540
12.0000	11.7500	0.9836	0.6000	29.7276
12.0000	12.0000	0.9836	0.6000	29.9012
12.0000	12.2500	0.9836	0.6000	30.0748
12.0000	12.5000	0.9836	0.6000	30.2484
12.0000	12.7500	0.9836	0.6000	30.4220
12.0000	13.0000	0.9836	0.6000	30.5956
12.0000	13.2500	0.9836	0.6000	30.7691
12.0000	13.5000	0.9836	0.6000	30.9427
12.0000	13.7500	0.9836	0.6000	31.1163
12.0000	14.0000	0.9836	0.6000	31.2899
12.0000	14.2500	0.9836	0.6000	31.4635
12.0000	14.5000	0.9836	0.6000	31.6371
12.0000	14.7500	0.9836	0.6000	31.8107
12.0000	15.0000	0.9836	0.6000	31.9842
12.0000	15.2500	0.9836	0.6000	32.1578
12.0000	15.5001	0.9836	0.6000	32.3314
12.0000	15.7500	0.9836	0.6000	32.5050
12.0000	16.0000	0.9836	0.6000	32.6786
12.0000	16.2500	0.9836	0.6000	32.8522
12.0000	16.5000	0.9836	0.6000	33.0257
12.0000	16.7500	0.9836	0.6000	33.1993
12.0000	17.0000	0.9836	0.6000	33.3729
12.0000	17.2500	0.9836	0.6000	33.5465
12.0000	17.5000	0.9837	0.6000	33.7201
12.0000	17.7500	0.9837	0.6000	33.8937
12.0000	18.0000	0.9837	0.6000	34.0672
12.0000	18.2500	0.9836	0.6000	34.2407
12.0000	18.5000	0.9835	0.6000	34.4143
12.0000	18.7500	0.9834	0.6000	34.5881
12.0000	19.0000	0.9836	0.6000	34.7619
12.0000	19.2500	0.9839	0.6000	34.9356
12.0000	19.5001	0.9843	0.6000	35.1087
12.0000	19.7500	0.9841	0.6000	35.2817
12.0000	20.0000	0.9834	0.6000	35.4549
-99.00000	-99.00000	-99.00000		

(vii) IN.DAT

```
       2
       0         0
1.000000       0.830000      -18.00000          9.80000      0.0000000E+00
      10         2
 4.500000      4.000000      0.0400000      0.0500000              160
      70  6.7000001E-02  0.0000000E+00    0.400000      0.0000000E+00
       1
       2
       2
       0         0
       0  0.0000000E+00  0.0000000E+00
       0
       0
       2
       3    3.10    0.70    2.30    1.60    0.00    1.60
       3    3.10   -0.70    2.30   -1.60    0.00   -1.60
DOUBLE BREAKWATERS
       2
2.800000       -4.500000       2.800000        4.500000
2.000000       -4.500000       2.000000        4.500000
```

(viii) DEPTH.DAT

```
0
0.0   0.0
0.1   0.1
0.2   0.2
0.22  0.22
0.24  0.24
0.32  0.32
0.40  0.40
0.40  0.40
0.40  0.40
0.40  0.40
```

(ix) LOC.DAT

```
0
0.0  1.5  3.0  3.3  3.6  3.9  4.2  4.5  5.0  20.0
0
-50. 50.
```

(x) OUT01.DAT

DOUBLE BREAKWATERS

AMPLITUDE = 1.000 PERIOD = 0.830

ANGLE = 0.000 GRAVITY = 9.800 TIDE = 0.000

REFERENCE POINT = (4.500 , 4.000)

N = 160 NN = 70 M = 70

DSIG = 0.040 DRHO = 0.050 IOPTCO = 2 IOPTBU = 0 IOPTBD = 0

IBACKD = 2 IREALD = 2 IBREAK = 0 ICURRN = 0

IFRCT = 0 XDAMP = 0.000 FRCT = 0.0000E+00 IBKWTR = 2

BREAKWATER NO. = 1 POINTS ON THE BREAKWATER = 3

3.1000 0.7000 2.3000 1.6000 0.0000 1.6000

BREAKWATER NO. = 2 POINTS ON THE BREAKWATER = 3

3.1000 -0.7000 2.3000 -1.6000 0.0000 -1.6000

SECTION FROM (2.800 , -4.500) TO (2.800 , 4.500)

X - COORD.	Y - COORD.	AMPLITUDE	DEPTH	PHASE VALUE
2.8000	4.0000	0.9430	0.1867	10.1990
2.8000	3.9500	0.9488	0.1867	10.3029
2.8000	3.9000	0.9543	0.1867	10.4061
2.8000	3.8500	0.9592	0.1867	10.5087
2.8000	3.8000	0.9632	0.1867	10.6108
2.8000	3.7500	0.9663	0.1867	10.7124
2.8000	3.7000	0.9682	0.1867	10.8135
2.8000	3.6500	0.9691	0.1867	10.9140
2.8000	3.6000	0.9688	0.1867	11.0141
2.8000	3.5500	0.9673	0.1867	11.1134
2.8000	3.5000	0.9648	0.1867	11.2120
2.8000	3.4500	0.9613	0.1867	11.3096
2.8000	3.4000	0.9570	0.1867	11.4063
2.8000	3.3500	0.9519	0.1867	11.5017
2.8000	3.3000	0.9464	0.1867	11.5959
2.8000	3.2500	0.9406	0.1867	11.6887
2.8000	3.2000	0.9348	0.1867	11.7801
2.8000	3.1500	0.9293	0.1867	11.8700
2.8000	3.1000	0.9245	0.1867	11.9585
2.8000	3.0500	0.9206	0.1867	12.0458
2.8000	3.0000	0.9180	0.1867	12.1322
2.8000	2.9500	0.9168	0.1867	12.2180
2.8000	2.9000	0.9173	0.1867	12.3039
2.8000	2.8500	0.9191	0.1867	12.3904

2.8000	2.8000	0.9222	0.1867	12.4779
2.8000	2.7500	0.9261	0.1867	12.5667
2.8000	2.7000	0.9304	0.1867	12.6570
2.8000	2.6500	0.9346	0.1867	12.7486
2.8000	2.6000	0.9384	0.1867	12.8414
2.8000	2.5500	0.9415	0.1867	12.9352
2.8000	2.5000	0.9437	0.1867	13.0296
2.8000	2.4500	0.9450	0.1867	13.1242
2.8000	2.4000	0.9455	0.1867	13.2187
2.8000	2.3500	0.9453	0.1867	13.3130
2.8000	2.3000	0.9446	0.1867	13.4069
2.8000	2.2500	0.9436	0.1867	13.5004
2.8000	2.2000	0.9424	0.1867	13.5934
2.8000	2.1500	0.9411	0.1867	13.6860
2.8000	2.1000	0.9399	0.1867	13.7781
2.8000	2.0500	0.9388	0.1867	13.8698
2.8000	2.0000	0.9377	0.1867	13.9611
2.8000	1.9500	0.9367	0.1867	14.0522
2.8000	1.9000	0.9357	0.1867	14.1437
2.8000	1.8500	0.9354	0.1867	14.2359
2.8000	1.8000	0.9371	0.1867	14.3283
2.8000	1.7500	0.9409	0.1867	14.4185
2.8000	1.7000	0.9438	0.1867	14.5036
2.8000	1.6500	0.9385	0.1867	14.5849
2.8000	1.6000	0.9198	0.1867	14.6747
2.8000	1.5500	0.8989	0.1867	14.7940
2.8000	1.5000	0.9136	0.1867	14.9427
2.8000	1.4500	0.9946	0.1867	15.0632
2.8000	1.4000	1.1064	0.1867	15.0879
2.8000	1.3500	1.1434	0.1867	15.0017
2.8000	1.3000	0.9852	0.1867	14.8454
2.8000	1.2500	0.5757	0.1867	14.8167
2.8000	1.2000	0.4566	0.1867	15.9091
2.8000	1.1500	1.0281	0.1867	16.4329
2.8000	1.1000	1.6936	0.1867	16.1874
2.8000	1.0000	0.4439	0.1867	18.3782
2.8000	0.9500	0.3937	0.1867	18.0859
2.8000	0.9000	0.3997	0.1867	17.8172
2.8000	0.8500	0.3872	0.1867	17.5011
2.8000	0.8000	0.3792	0.1867	17.3001
2.8000	0.7500	0.3986	0.1867	17.0962
2.8000	0.7000	0.4138	0.1867	16.9229
2.8000	0.6500	0.4464	0.1867	16.8031
2.8000	0.6000	0.4861	0.1867	16.7007
2.8000	0.5500	0.5417	0.1867	16.6552
2.8000	0.5000	0.5954	0.1867	16.6351
2.8000	0.4500	0.6711	0.1867	16.6388
2.8000	0.4000	0.7537	0.1867	16.6981
2.8000	0.3500	0.8206	0.1867	16.7796
2.8000	0.3000	0.8920	0.1867	16.8650
2.8000	0.2500	0.9786	0.1867	16.9835
2.8000	0.2000	1.0517	0.1867	17.1492
2.8000	0.1500	1.0783	0.1867	17.3331
2.8000	0.1000	1.0513	0.1867	17.4900
2.8000	0.0500	0.9880	0.1867	17.5942
2.8000	0.0000	0.9175	0.1867	17.6595
2.8000	-0.0500	0.8673	0.1867	17.7338
2.8000	-0.1000	0.8617	0.1867	17.8513
2.8000	-0.1500	0.9130	0.1867	17.9823
2.8000	-0.2000	0.9924	0.1867	18.0717

2.8000	-0.2500	1.0432	0.1867	18.1129
2.8000	-0.3000	1.0410	0.1867	18.1438
2.8000	-0.3500	1.0115	0.1867	18.1922
2.8000	-0.4000	0.9782	0.1867	18.2477
2.8000	-0.4500	0.9278	0.1867	18.3029
2.8000	-0.5000	0.8594	0.1867	18.3847
2.8000	-0.5500	0.7996	0.1867	18.4948
2.8000	-0.6000	0.7399	0.1867	18.6156
2.8000	-0.6500	0.6822	0.1867	18.7718
2.8000	-0.7000	0.6365	0.1867	18.9447
2.8000	-0.7500	0.5972	0.1867	19.1493
2.8000	-0.8000	0.5644	0.1867	19.3728
2.8000	-0.8500	0.5470	0.1867	19.6158
2.8000	-0.9000	0.5348	0.1867	19.9035
2.8000	-0.9500	0.5209	0.1867	20.1921
2.8000	-1.0000	0.5338	0.1867	20.5041
2.8000	-1.1000	1.5760	0.1867	19.7180
2.8000	-1.1500	1.3577	0.1867	20.0088
2.8000	-1.2000	1.0826	0.1867	20.1972
2.8000	-1.2500	0.8534	0.1867	20.2281
2.8000	-1.3000	0.7624	0.1867	20.1372
2.8000	-1.3500	0.8052	0.1867	20.0725
2.8000	-1.4000	0.8894	0.1867	20.1223
2.8000	-1.4500	0.9468	0.1867	20.2389
2.8000	-1.5000	0.9662	0.1867	20.3678
2.8000	-1.5500	0.9616	0.1867	20.4847
2.8000	-1.6000	0.9499	0.1867	20.5855
2.8000	-1.6500	0.9411	0.1867	20.6755
2.8000	-1.7000	0.9374	0.1867	20.7622
2.8000	-1.7500	0.9367	0.1867	20.8500
2.8000	-1.8000	0.9368	0.1867	20.9402
2.8000	-1.8500	0.9365	0.1867	21.0324
2.8000	-1.9000	0.9359	0.1867	21.1257
2.8000	-1.9500	0.9354	0.1867	21.2194
2.8000	-2.0000	0.9356	0.1867	21.3132
2.8000	-2.0500	0.9366	0.1867	21.4068
2.8000	-2.1000	0.9383	0.1867	21.4996
2.8000	-2.1500	0.9406	0.1867	21.5915
2.8000	-2.2000	0.9428	0.1867	21.6823
2.8000	-2.2500	0.9445	0.1867	21.7719
2.8000	-2.3000	0.9452	0.1867	21.8606
2.8000	-2.3500	0.9444	0.1867	21.9489
2.8000	-2.4000	0.9419	0.1867	22.0375
2.8000	-2.4500	0.9378	0.1867	22.1274
2.8000	-2.5000	0.9328	0.1867	22.2195
2.8000	-2.5500	0.9279	0.1867	22.3144
2.8000	-2.6000	0.9244	0.1867	22.4119
2.8000	-2.6500	0.9236	0.1867	22.5111
2.8000	-2.7000	0.9262	0.1867	22.6105
2.8000	-2.7500	0.9320	0.1867	22.7082
2.8000	-2.8000	0.9401	0.1867	22.8027
2.8000	-2.8500	0.9489	0.1867	22.8930
2.8000	-2.9000	0.9566	0.1867	22.9792
2.8000	-2.9500	0.9614	0.1867	23.0622
2.8000	-3.0000	0.9622	0.1867	23.1438
2.8000	-3.0500	0.9588	0.1867	23.2256
2.8000	-3.1000	0.9517	0.1867	23.3096
2.8000	-3.1500	0.9421	0.1867	23.3972
2.8000	-3.2000	0.9314	0.1867	23.4891
2.8000	-3.2500	0.9216	0.1867	23.5857

2.8000	-3.3000	0.9142	0.1867	23.6865
2.8000	-3.3500	0.9107	0.1867	23.7899
2.8000	-3.4000	0.9117	0.1867	23.8942
2.8000	-3.4500	0.9173	0.1867	23.9973
2.8000	-3.5000	0.9269	0.1867	24.0973
2.8000	-3.5500	0.9391	0.1867	24.1928
2.8000	-3.6000	0.9524	0.1867	24.2831
2.8000	-3.6500	0.9652	0.1867	24.3681
2.8000	-3.7000	0.9756	0.1867	24.4483
2.8000	-3.7500	0.9824	0.1867	24.5246
2.8000	-3.8000	0.9844	0.1867	24.5982
2.8000	-3.8500	0.9809	0.1867	24.6704
2.8000	-3.9000	0.9717	0.1867	24.7425
2.8000	-3.9500	0.9570	0.1867	24.8160
-99.00000	-99.00000	-99.00000		